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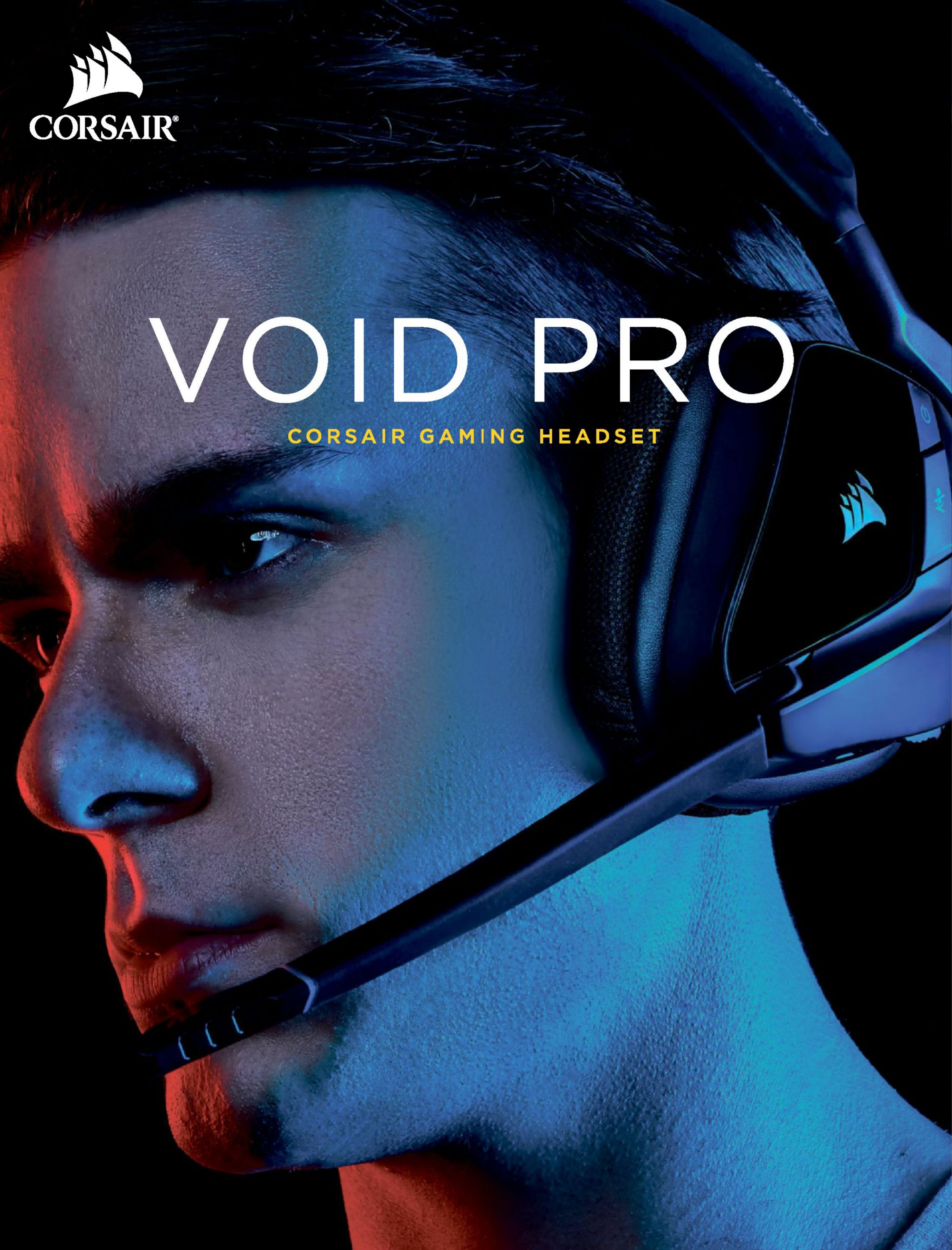

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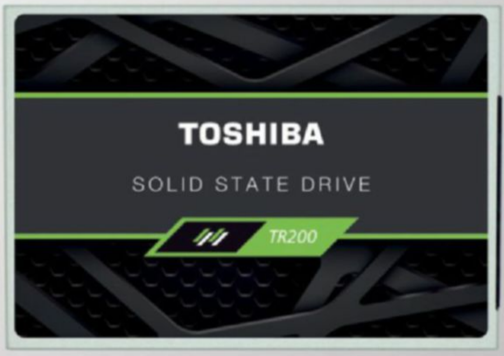

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Tuan
Nguyen

ONE BRAND OVER ANOTHER

FOR AS LONG AS COMPUTERS have been around, so have camps. And I'm not referring to the types of camps you find in the woods. I'm talking about sides—people choosing one side over another side, and fighting about things on a near religious level.

You see it everywhere: Mac versus PC. Android versus iOS. AMD versus Intel. People get really passionate about the brands they beholden themselves to. When this happens, things get really personal. Attacks are made and insults are tossed across the border, as though one had to defend themselves on a personal level.

I find this to be frustrating because conversations tend to deteriorate, and the merits of a product become lost. For me, focusing on empirical data yields much better results, although sometimes it's hopeless, even when data is presented.

For the most part, I consider myself to be campless. I go for the product that is best at that time, but I do take into consideration a brand's history. Has said brand shown a history of making reliable products or providing reliable service? It's easy to come up with one great product, but it's much more difficult to land a string of home runs. However, many people hold on dearly to their brands, whether their products are legitimately good or not. The funniest part is that the same people accuse others of the very guilt they themselves hold. I say, let the data speak for itself, and leave feelings out of it.

But it's difficult, isn't it? People get passionate about their hardware, and passions run high in the PC community. Make no mistake, though, it's no good for anyone when brands die.

Some might not remember, but there was a time when there were far more GPU options on the market than there are now. Today, I count two options. I liked it better when there were more: S3, ATI, Nvidia, Rendition, 3dfx, Matrox, PowerVR, BitBoys, 3Dlabs, Number Nine. I probably forgot a few, but wow, that was a truly glorious time. I wish those companies were still around. When there are more players in a space, innovation moves faster.

Right now, we're in a risky situation. If one of the major two players gets acquired or goes bankrupt, we're in big trouble. Not only does innovation plummet, but prices get affected, too. I always want all the players in the industry to do well.

Does that mean I wouldn't recommend one brand over another? No. There are some brands that I would absolutely recommend, while others I wouldn't, but that depends on the current product lineup as well as things like failure rates and customer service. Does that mean I wish the rotten apples would die off? Absolutely not. I want them to get their act together and make better products.

I plant my flag squarely in the middle. But I let my wallet do the talking.

Tuan

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 20 years.*

↘ submit your questions to: comments@maximumpc.com

THE NEWS

Equifax Loses Data on 143m Americans

Over half the adult population has personal data stolen

ON JULY 29, credit monitoring company Equifax discovered that over the previous weeks it had been hacked, and a huge amount of personal data had been stolen. This included full names and addresses, birth dates, social security numbers, driver's license numbers, and even credit card numbers. It is the biggest security breach since Yahoo in 2014. It's not just the sheer volume of data stolen, it's the quality. Equifax is used by financial institutions to check identities and credit worthiness of potential customers. The stolen data is ideal for credit fraud and identity theft.

Why are you reading this now? Because Equifax didn't say anything for more than five weeks. Once it had confessed, a website and hotline were set up for worried customers. Given the numbers involved, the hotline was quickly swamped (2,000 agents don't go far when you potentially have 143 million callers), and even if you did get through, it merely pointed you toward the website, as the agents had no access to Equifax accounts. The website suggests you sign up for a free year's worth of its credit-monitoring service (hardly tactful, especially as initially the terms and conditions mean you can't participate in a class-action suit against Equifax if you take the offer). The site also proved unhelpful for many, reporting that their data "may" have been lost. It doesn't help that most people don't know if Equifax has their data in the first place.

Upon the announcement, Equifax stock took a 13 percent tumble. It also emerged that three of its top executives had sold shares, $1.8m worth in all, between the breach and before the public announcement. This is, at best, poor timing. At worst, it looks illegal. The company claims that the executives had "no knowledge that an intrusion had occurred at the time they sold their shares."

Equifax has been weathering a storm of criticism. When such important personal data is lost, you need to know, and know at once. Waiting five weeks while worried executives brainstorm damage limitation scenarios is unacceptable. Identity theft can cause huge damage—having your credit rating destroyed is no joke, for a start.

Senator Mark Warner, vice chair of the Senate Intelligence Committee, called the data loss "profoundly troubling." He has called for a rethink in data protection policies, so that there are "fewer incentives to collect large, centralized sets of highly sensitive data." The House Financial Service Committee and the House Judiciary Committee have both said they will hold hearings on the breach. There will be lawsuits, of course—class actions in every state are in the pipeline, the first of which have been filed.

What has Equifax to say about all this? In a statement, its CEO, Richard Smith, said, "This is clearly a disappointing event for our company, and one that strikes at the heart of who we are and what we do." He also said that the company was "conducting a thorough review of our overall security operations." Bolt. Horse.

The breach also highlights what many security experts have been saying for some time now. Using personal data, such as your birthday and mother's maiden name, are poor ways to validate identity. Such data is too easy to discover and is spread too widely.

Please don't panic. Stealing data is one thing, an organized attempt to use it illegally is another. Keep an eye on your accounts, and monitor your credit rating if you're worried. You will be forgiven if you eschew Equifax's own service. As yet, we have no idea who stole the data, and there have been no reports of any of it being used maliciously. However, this is a big breach, and we'll be hearing more: lawsuits and legislation, if nothing else. **–CL**

> Equifax CEO, Richard Smith, said, "*This is clearly a disappointing event for our company, and one that strikes at the heart of who we are and what we do.*"

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AMD RADEON GRAPHICS

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HOW IS THIS FOR A DEAL? Take your $9.95 a month MoviePass card into any theater that takes debit cards, swipe, and get a ticket, one per day. This is the new deal from MoviePass, and it has proved popular—subscriptions jumped from around 20,000 to over 150,000 in just two days.

MoviePass has been around since 2011. It started with a cumbersome voucher system, and then ran through various pricing structures, none especially cheap. In 2016, one of Netflix's founders, Mitch Lowe, became CEO. This year, the company was bought out by the analytics firm Helios and Matheson, and on the same day it announced the business model that has done Netflix and others so well: a cheap flat-rate subscription that lets you binge if you wish.

The huge surge in subscriptions has prompted teething troubles, including crashed websites, and delayed delivery of membership cards. Supposedly, you can also access the service using a smartphone app to buy e-tickets, but few theaters accept them, and it has been troublesome. The app has also proved to be awkward, demanding, and unpopular.

MoviePass faces problems from within the industry, too, including a spat with AMC Theaters, the largest chain in the country, which is reportedly looking for a way to block MoviePass subscriptions. It claims the deal is "shaky and unsustainable." Come on, guys, you still get paid full price, and think of all the extra popcorn you can sell.

Will it work? Mitch Lowe says he has the numbers and data to show it will. The company wants your data, of course, to use for targeted advertising and promotions. It also hopes to get a slice of movie marketing cash, from recommendations and "pay for performance" (basically a kickback). MoviePass even hopes to invest in filmmaking in time. Heavy users will lose the company money, but if it can reach big numbers, it'll even out. There are a lot of industry people watching this one. **–CL**

LENOVO FINALLY FINED

LAPTOPS SOLD WITH ADWARE INSTALLED

THE WHEELS OF THE LAW may move slowly, but they get you in the end. In 2015, it emerged that Lenovo had been selling laptops that came pre-installed with adware called VisualDiscovery, from SuperFish. This pushed pop-up ads from Lenovo partners when you mouse over similar content. It also collected a lot of data without your consent. Most worryingly, it messed with Digital Certificates, replacing them with less secure versions. A fuss was made, and a removal tool offered. Lenovo claimed to be unaware of the security implications. The Federal Trade Commission has said the company must gain user permission for any future adware, as well as test its software for security flaws for the next 20 years. The company also took home a $3.5 million fine. **–CL**

JUICERO SQUEEZED OUT

$134 million investment gone within 16 months

THE JUICERO IS, or rather was, an Internet-enabled machine that squeezed sachets of fresh vegetables and fruit into juice. As a start-up, the San Francisco company attracted some big-name investors, including Google Ventures. The $699 machine it finally delivered was lovely, but hugely over-engineered. It didn't help that you could squeeze some of the packs by hand with very similar results. The machine would only squeeze branded packs, and refused anything out of date, no matter how wholesome it still was. Dropping the price to $399 didn't help, especially as it was losing money, even at the higher price.

It will be remembered, though. As a triumph of optimism over reality more than anything else; it has been the victim of much schadenfreude and mockery. Some investors say that an anti-elitist media helped bring it down—it can't have helped. But they were trying to sell a $400 juice press that only used proprietary sachets. The company has given people 90 days to apply for a refund. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **XBOX ONE GETS KEYBOARD AND MOUSE**
At last, you can use PC-style game controls on your console, possibly in time for Xmas.

✓ **AMD OUTSELLS INTEL**
OK, it's only according to one German retailer so far, but AMD sales are buoyant.

✓ **NEW SAFE BATTERY**
A new full-power Lithium-ion battery is in the labs that won't catch fire or explode.

TRAGEDIES

✗ **VOICE ASSISTANT HIJACK**
It turns out they can be controlled by sounds beyond human hearing.

✗ **CHINA BANS ICOS**
Only "temporary," but signs are that the Chinese state is moving to curb and control cryptocurrencies.

✗ **FAKE LIKES**
A security hole in Facebook has enabled the creation of 100 million fake "likes."

Jarred Walton

TECH TALK

The Blockchain Bonanza

CRYPTOCURRENCIES have been big news for several months, with prices on many graphics cards shooting into the stratosphere—for a while, it was almost impossible to find AMD's RX 570 or 580 at anything resembling a reasonable price. The cause: cryptocurrency miners.

GPU	RIG PRICE	DAILY INCOME	TIME TO BREAK EVEN
GTX 1080 Ti	$5,160	$19.08–$20.99	246–270 days
GTX 1080	$3,888	$16.74–$18.41	211–232 days
GTX 1070	$3,414	$13.32–$14.65	233–256 days
GTX 1060 6GB	$2,430	$8.88–$9.77	249–274 days
GTX 1060 3GB	$2,100	$7.99–$8.79	239–263 days
RX Vega 64	$4,920	$17.68–$19.44	253–278 days
RX Vega 56	$3,720	$17.00–$18.70	199–219 days
RX 580 8GB	$3,282	$10.32–$11.35	289–318 days
RX 570 4GB	$2,688	$9.30–$10.23	263–289 days

Time taken to break even on the investment in a mining PC with six GPUs.

This isn't the first time we've seen GPU prices and availability affected by cryptocurrencies—in summer 2011, there was a rush to buy AMD's HD 5870, and in late 2013/early 2014, the same thing happened with the R9 290/290X. It's also unlikely to be the last we hear of GPU-based cryptocurrency mining, as both AMD and Nvidia CEOs have mentioned the influence of "coin miners" on the GPU market, and several partner companies have released dedicated mining cards (a GPU without video outputs).

However, where GPUs were once useful for mining Bitcoin directly, then used for other options such as Litecoin and Dogecoin, today the algorithms used by Bitcoin and Litecoin have transitioned to ASICs—Application Specific Integrated Circuits designed purely for blockchain related solutions. But that doesn't mean graphics cards are out of the picture, as new algorithms have sprung up that are currently best run on GPUs. Two prominent examples are Ethereum and Zcash, the former of which is largely to blame for the shortage of AMD GPUs.

Ethereum isn't new—it officially launched July 30, 2015. Like other cryptocurrencies, initial pricing was guesswork, with no one knowing if it would succeed. ETH prices remained below $10 during 2015, first breaking into double digits in March 2016, but that was nothing compared to what happened in 2017. First, there was a surge from single digits back into double digits in January, followed by record highs of up to $50 in March—then April and May happened, with ETH rocketing up to a high of around $400.

Suddenly everyone wanted in on the action, and in May a single RX 580 graphics card could earn over $5 per day from mining Ethereum—so it could pay for itself in under a month. Inventory disappeared, with prices hitting $600 and more on auction sites. Nvidia cards weren't unscathed, as Zcash and other coins provided similarly insane returns, though the GTX 1080/1080 Ti mostly avoided going out of stock.

As the dust continues to settle, we're still waiting for GPU prices to return to normal—"normal" being prices at or below the original MSRPs. AMD's Radeon RX 570 4GB is nominally supposed to start at $170, and the RX 580 8GB at $240, but the last time we saw those prices was in April. Similarly, the GTX 1070 is supposed to start at $380, and in March/April we saw prices fall to $350, but combined with increased demand for GDDR5, we've witnessed higher graphics card prices on virtually all products.

The question many still have is whether GPU mining is worthwhile at these prices. The short answer: Probably not. The longer answer: It's a gamble, but right now, on a daily basis, most cards generate more potential money (in digital currencies) than they use in power, making them profitable.

I ran some tests of current-gen cards, to see what returns are possible, using a cost of $0.10 per kWh. You can see the approximate time to break even for a complete mining rig above. This is only an estimate, however, as prices and the difficulty of mining remain volatile.

It could take more than twice as long as shown, and if hardware breaks, which is a possibility when running gaming GPUs at full load 24/7, you might never break even. But if you're an optimist, even the current prices of over $300 for Ethereum and $4,400 for Bitcoin (at the time of writing) are undervalued.

That hope of striking it rich is why many continue to invest in PC hardware—and why it's called "mining," in reference to gold rushes. Don't be surprised if, like the gold rush, the biggest winners are the companies that supply the hardware, rather than the miners.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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Alex Campbell

OPEN SOURCE

How GitHub Led Me to a Better Version of Keybase

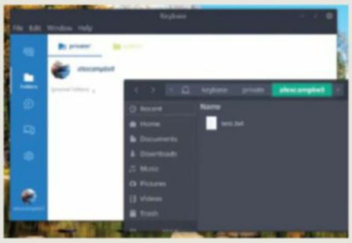
I'VE HAD A KEYBASE.IO ACCOUNT for a couple years now. Even though I've never had the need to send encrypted messages to anyone, I've still kept my account current. As a writer, you never know whether someone will drop the next scoop in your lap. But, if I'm being honest, I've really kept it because crypto tech is just plain cool.

It took me over a year to check out some of Keybase's features. Imagine my surprise when I was tooling around on the Keybase website and started reading about something called the Keybase filesystem. Sounds neat. But it was nowhere to be found in the version that came in my distro's official repository. Curious, I tried the version available on GitHub.

It turns out that the KBFS is a mountpoint (using Fuse) located at "/keybase" on your system. Files stored in subfolders of that path are automatically encrypted and/or signed for the recipients. A path such as "/keybase/public/alexcampbell" signs files and makes them available to anyone on the Internet. Saving a file to "/keybase/private/alexcampbell" encrypts the file so that only I can read it. Finally, saving a file to "/keybase/private/alexcampbell,bob" encrypts the file so only Bob and I can read it, and automatically shares it with Bob. I said it was neat.

If you're not familiar with Keybase.io, it's a service that's built to solve one of the problems that's plagued PGP: Authentication and establishing trust in someone's identity is hard. There's no real name enforcement when you create a PGP key. If you want to use the name Barack Obama and the email barackobama@whitehouse.gov, nothing stops you.

That doesn't sound so bad, but keyservers—the traditional repositories of public keys—don't enforce identities either. The only thing you can use to identify a unique key is its fingerprint. In a way, a keyserver is a place where anyone can jump up and claim "I'm Spartacus!" Unless the poor Roman soldier has a copy of the true Spartacus's fingerprint handy, there's no reliable way to tell these jokers from the real McCoy.



The Keybase app and a folder showing the Keybase filesystem.

> The Keybase service is like shouting "I'm Spartacus!" while holding up a birth certificate and driver's license.

Keybase fixes this problem by allowing users to offer up their public key as well as authenticated links to social media accounts, GitHub accounts, and personal websites. It's like shouting "I'm Spartacus!" while holding up a birth certificate and driver's license.

The Keybase filesystem is cloud storage in disguise. But it encrypts your files client-side (on your PC) before uploading them. As long as you keep your private keys to yourself, no one can read the files. There's no sync model, so you can only access the filesystem when online. If you really need sync capability, you can use rsync.

I like the fact that crypto is getting easier. Signal makes crypto as easy as pie for text messaging. However, sending files via Signal is less than ideal on desktop. Keybase makes sharing encrypted files a snap on top of its simplification of PGP.

Keybase offers 10GB of free storage for its filesystem; Google Drive's free tier is 15GB. On top of that, files you share with others don't count against your friends' quota. That means if you share photos of your trip to the Everglades with your uncle Jim, he won't curse your name for eating up all his storage space with blurry photos of what you claim are alligators.

If there's a lesson to take away from all this (besides the fact that free encrypted file storage is kind of awesome), it's that there's often more to software packages than meets the eye. Updating your system gives you the latest patches to keep your system secure. But if you look beyond the repo, sometimes you can find something awesome that you never knew existed.

Alex Campbell is a Linux geek who enjoys learning about computer security.

THE LIST

8 ALTERNATIVES TO CRASHPLAN'S CANCELED CLOUD BACKUP

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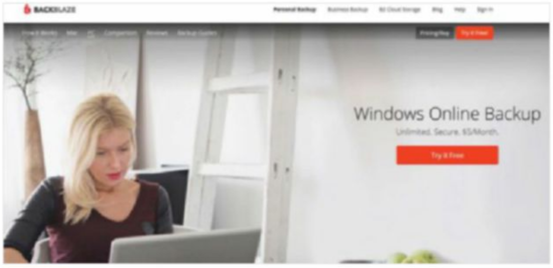
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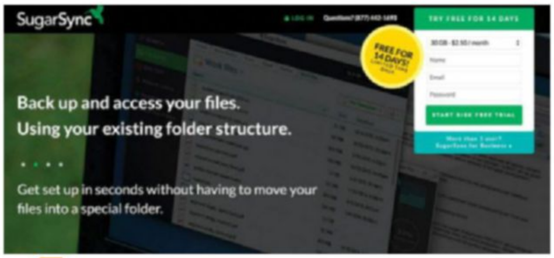
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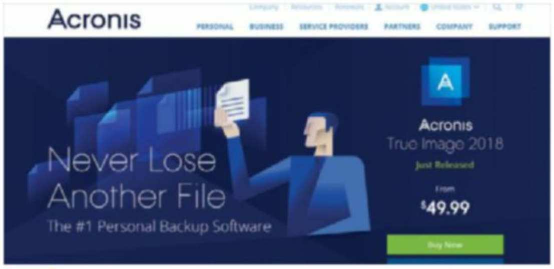
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2 DUPLICATI *Free*

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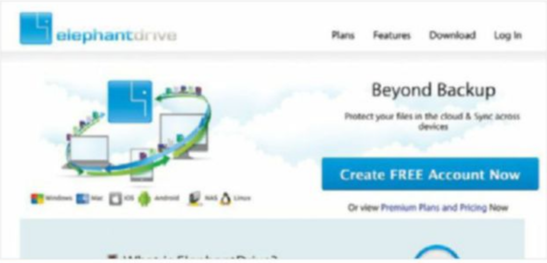
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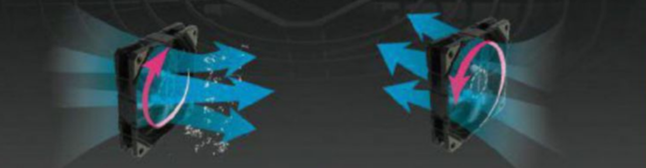

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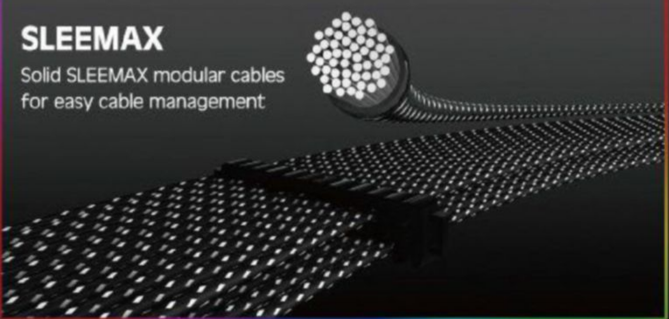

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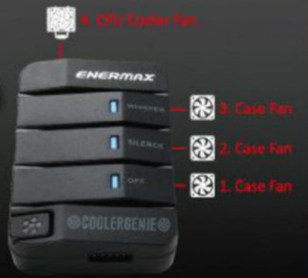
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HEAD TO

BY **ALEX COX**

Xbox One S vs. PS4 Pro vs. Nintendo Switch

As we crawl toward the end of the eighth generation of games consoles, hardware revisions mean prices have come down and capabilities have gone up. Time to pick the best, with a couple of caveats. One: The imminent release of the Xbox One X may skew these results significantly, but we're working with the hardware that's actually on the market at press time. Two: We've not included the PC. Why? Because we know, and you know, that a properly upgraded PC will trounce any of these made-to-a-budget boxes in just about every test.

ROUND 1

Gaming

Each of these machines has its own software library, with worthy exclusives on each platform, although the Switch's selection of Nintendo classics stands out the most: You certainly won't find the latest *Mario* or *Zelda* titles hitting any of the other consoles. That said, it was the latest console to launch, and has only a tiny fraction of the library of its big-boy rivals.

The Switch also possesses only a sliver of the power of its competitors. It theoretically tops out at 1080p, but spends most of its time dynamically scaling the resolution so things stay smooth, and its handheld mode supports only 720p (given that's the resolution of its panel), and compensates for its processor's mobile power scaling with some hefty frame rate drops.

On the other side of the fight, the Xbox One S swishes through the console's huge 1080p library very happily, boosting picture quality on 4K TVs with some neat HDR effects, while the PS4 Pro manages to go one better, with some games offering true 4K video modes—although developers are not shy of dynamic resolution scaling when things begin to get a little choppy.

Winner:
PS4 Pro

ROUND 2

Media Playback

Let's quickly sidestep the Switch here, which has, basically, no media playback skills at all. At press time, Nintendo has not even offered up an official web browser, although a few enterprising individuals have found workarounds that enable you to at least get YouTube sort of working.

So, we're left with the Xbox One S and the PS4 Pro, and one of the most perplexing design decisions in console history. Sony, originator of the Blu-ray format—the same format that flattened Microsoft-backed HD-DVD so long ago, the one that sold a metric ton of PS3s for Sony back in the day—released the PS4 Pro with no Ultra-HD Blu-ray support at all. The Xbox One S, on the other hand, can play back UHD discs, and it's just about the cheapest 4K Blu-ray player on the market. It's not the best, but it does the job.

That's not to say the PS4 Pro is completely neutered in this department, though. It can play 4K footage from USB media—and, frankly, most of us have moved beyond optical media now, right? But the Xbox One S can do that, too, and picture quality is all but indistinguishable between them.

Winner:
Xbox One S

ROUND 3

Upgradability

Coming at consoles from a PC enthusiast perspective, it's difficult not to feel a little smug when discussing upgradability. If we want a higher frame rate or a resolution upgrade, we pick up a new GPU, some more RAM, a beefier processor. It's possible to boost a PC entirely piecemeal, something that consoles are yet to approach. However, it's a matter of perspective—compare the possibility of swapping an existing Xbox One S with the marginally better Xbox One X, due for release at $500, to sticking a $1,200 Titan X in your PCIe slot. That's not all that bad, although obviously the PC component is rocking a massive amount more power.

The real upgrade potential for games consoles comes in the form of their peripherals. Nintendo's tactic is to sell you an overpriced controller that's actually made for human thumbs. You can boost a regular Xbox One S with a Kinect for a little voice and camera interactivity. But Sony wins the day here, with its PSVR headset. Yes, the PSVR game library isn't the best, but this is 120Hz console VR, with a supremely designed helmet that's both comfortable and straightforward to set up.

Winner:
PS4 Pro

HEAD

From left to right:
2016's Xbox One S is the first major revision of Microsoft's Xbox One hardware.
Sony's PS4 Pro added 4K rendering via a massively upgraded GPU.
The Switch continues Nintendo's tradition of innovation.

ROUND 4

Cost

Comparing our three videogame consoles merely on the basis of price offers up a clear winner. The 1TB flavor of the Xbox One S (retailing at $349) beats out the 1TB PS4 Pro ($399) and the Nintendo Switch ($369) handily. Opt for the 500GB flavor, though—something that Sony isn't offering—and the Xbox can be had for as little as $249. The value equation is only likely to shift further in its favor once the Xbox One X hits the shelves.

However, there are further costs to consider. Additional controllers, for example, to enable local multiplayer, come in at a painful $60 for both Sony and Microsoft's consoles, though you may be able to find them cheaper somewhere. Nintendo's cunning design philosophy means its detachable Joy-cons make the Switch multiplayer-compatible from the get-go, as long as you're happy with hand cramp. It also comes with its own screen; if you factor in the cost of a display, it's by far the value winner. But we'd wager you have a TV already, which makes that a moot point, and to really make the most of the Switch, you need to add an SD card and, realistically, a $70 pro controller.

Winner:
Xbox One S

ROUND 5

Form Factor and Flexibility

Finally, it's time for the Switch to shine. You can play it handheld, you can play it docked and attached to your TV. You can use its Joy-cons loose, attached to a little plastic grip, held in all kinds of implausible positions. It really does offer up a huge number of options that ordinary box-under-the-TV consoles can't. However, you can't slide it neatly on to a shelf in your living room, because you need vertical access to its dock to insert it. And you can't actually do anything else with it beyond playing its limited library of games.

The Xbox One S and PS4 Pro aren't just games consoles—they're media streamers, they're (poor) Internet access devices. They connect you to a community. Tuck them away and (assuming you've chosen the black version of the Xbox, rather than the gaudy white one) they're subtle and unassuming. You can even stream games from each directly to your PC or to Twitch. We can't put an inch between them in terms of their flexibility, and there's something about the plug-and-play nature of a traditional console that really can't be beat.

Tie:
Xbox One S, PS4 Pro,
Nintendo Switch

And the Winner Is...

Poor Nintendo. The company has created a tremendously exciting device in the Switch, one that puts proper next-gen games right into your hands, and makes a perfect home for its massive range of iconic characters. But it couldn't possibly win our test, because it's essentially some cheap tablet hardware in disguise.

And so to the eternal schoolyard battle between Xbox and PlayStation. Neither shines brighter than the other. Which game library you prefer is down to personal taste, their media capabilities are exceptionally close, and even the online services—PlayStation Plus and Xbox Live Gold—are similarly priced with very similar benefits.

At the end of the day, every argument boils down to a cost/benefit analysis, and that's how we must settle this one. The Xbox One S is so much cheaper than its rival, with the added benefit of UHD Blu-ray support, that we've granted it the top spot. Whether the forthcoming Xbox One X does enough, in hardware terms, to overcome a $100 price deficit over the PS4 Pro is another matter altogether.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> RAM Drive Benefits
> A Trio of Monitors
> Laptop Constraints

RAM Drive Dilemma

Dear Doctor, I have built a number of computers, and on all of them, I set up a 24GB RAM drive, and point my temporary directories there. I do this for three reasons. First, I believe it speeds up the machine, particularly the Internet, which seems to read and write a lot of files. Second, I use an SSD for programs, and a mechanical hard drive for writing to, and I think using a RAM drive as intermediate storage space saves wear and tear on those other devices. And third, when I need to hold a file just long enough to send it somewhere else, I store it on the RAM drive to prevent clutter on disk.

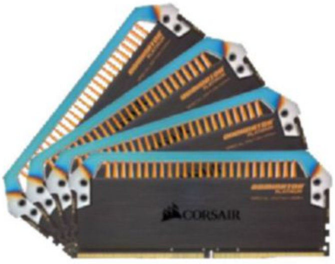
Aside from the rare mistake where I work on a file on the RAM drive, I haven't suffered from the fact that files disappear when I reboot. When I had less RAM, sometimes the temp drive was too small. But at 24GB, I've never had a problem.

Do you see anything wrong with what I am doing? If so, what? And is there a RAM drive utility that you favor?
–Neal Nusholtz

THE DOCTOR RESPONDS: Back when the Doc spent his nights and weekends running scripts to benchmark CPUs, RAM drives played a critical role in preventing storage bottlenecks. Around the time Intel introduced its Nehalem architecture, however, the company also started shipping X25-M SSDs. Shortly thereafter, the Doc stopped using RAM drives and started running his test suite from solid-state storage.

The point is, for nearly a decade, SSDs have largely addressed the performance concerns that once made RAM drives necessary for I/O-bound applications. They've evolved a ton, too. Today's PCIe SSDs can move gigabytes of information a second. Their NAND flash does have a finite lifespan (rated in program-erase cycles), so it's understandable that you're looking to minimize wear and tear. But most consumer SSDs are plenty robust for common desktop use. And although the Doc appreciates the use of volatile storage to mitigate clutter, he'd rather have 100 files he doesn't need than lose one he does.

In the end, there's nothing wrong with what you're doing. It's just not economically sensible. Presumably, to set aside 24GB of RAM, you'd want 64GB installed. At $500 for four 16GB modules, that's almost $8/GB. Good enterprise-class SSDs sell for $1/GB. A 32GB memory kit, high-end SSD, and roomy mechanical disk should address your concerns, save money, and step around the limitations of RAM drives.



Don't go heavy on memory just to run a RAM drive. A fast SSD is more economical.

Multiple Monitors

Hello Doctor, I have an HP Slim Desktop 410-030. It currently supports up to two monitors. But it also has a PCI Express 2.0 slot. I'm looking for a low-profile PCIe 2.0-compatible graphics card that I can use to attach three displays for business use.

I tried an Asus EN210 Silent video card with 1GB of RAM. Although it has connections for three monitors, I was only able to use two of them. The third monitor could only be used as a mirror of one of the others. I called Asus and it said that PCIe 2.0 only works with two monitors. Is it correct? Will I have to use a USB-based video card to add a third display? **–Leon Garfield**

THE DOCTOR RESPONDS: It sounds as though the Asus rep was mistaken. Your limitation isn't related to PCI Express, but rather the GeForce 210's GT218 graphics processor, which can only output to two independent displays simultaneously. For what it's worth, a 16-lane PCIe 2.0 slot offers up to 8 GB/s of throughput—bandwidth isn't an issue here.

Based on pictures of your chassis and the Shave-HSW motherboard that HP uses, a low-profile graphics card is mandatory. But it doesn't need to live in a single expansion slot. There's room under the motherboard and, more importantly, there's another I/O bracket to accommodate a dual-slot form factor.

If you'd like to avoid analog VGA output and are willing to spend $120 or so, several low-profile GeForce GTX 1050s support as many as four monitors through DVI, HDMI, and DisplayPort connectors. Nvidia recommends a 300W power supply for these cards. Because you won't be gaming, though, the HP's 180W 80 PLUS Bronze PSU shouldn't have to work hard at all.

↘ submit your questions to: doctor@maximumpc.com

Choosing an Upgrade

Hey Doc,I have an eight-year-old Alienware Area-51 (Phobos) PC that's showing its age. I'm hoping you can help me modernize it, as I spent a lot on it, and can't afford to buy or build a new machine right now. The system's current specs include a water-cooled Core i7-975 processor, 12GB of RAM, two GeForce GTX 295s in SLI, two 10K rpm 300GB VelociRaptor hard drives in RAID 0, and two 1.5TB storage disks in RAID 1.

I also have four 750GB Samsung 840 EVOs lying around. Do you recommend that I install them and sling them together in a RAID array? Also, what's the best single GPU that I could purchase for my motherboard (I don't know its make or model) that would allow me to play *The Division* or *Call of Duty: Infinite Warfare?*

–An Out-of-Money Gamer

THE DOCTOR RESPONDS: Back in the day, Core i7-975 Extreme Edition was cream of the crop. Its complementary platform controller hub, X58, offered up to 36 lanes of PCI Express 2.0 connectivity, 32 of which your GeForce GTX 295s are monopolizing (to the tune of almost 300W per card).

It would help to know the native resolution of your monitor. Given the age of your PC, though, the Doc is going to guess 1920x1080 (actually, 1920x1200 was more prevalent back then). If that's the case, a GeForce GTX 1060 6GB would better support modern DirectX 12/Vulkan graphics APIs, offer plenty of performance, cut power consumption, and crank out way less heat than those GTX 295s. If you're running at 2560x1440, a GeForce GTX 1070 would be more apropos for first-person shooters, but it's also pricier.

Now, about those Samsung 840 EVO SSDs. They're lying around, you say? That's 3TB of solid-state storage! Get at least one of them into your PC with Windows on it. The difference in responsiveness, even compared to the once-mighty VelociRaptors, will make you wonder why you didn't make the switch sooner.

Use M.2 and 2.5-inch SSDs to maximize your laptop's capacity.

Laptop Storage Limits

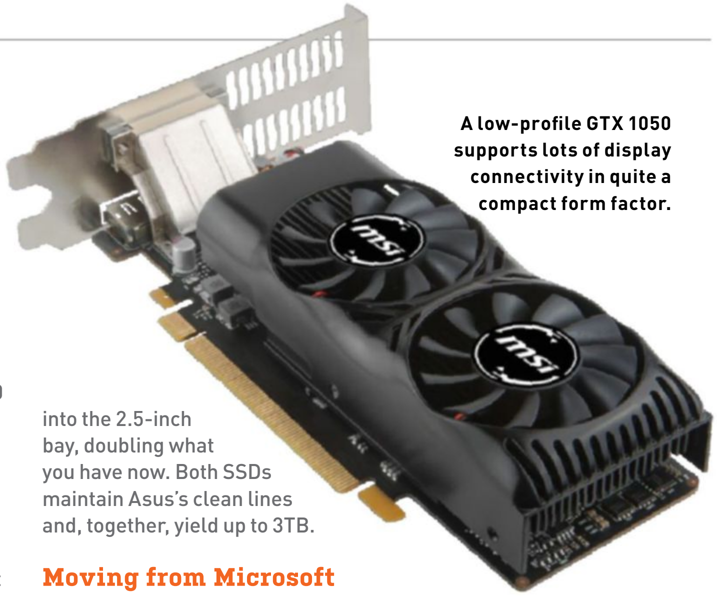
Hi Doc, I am a long-time *Maximum PC* subscriber, and I love your mag! I have an Asus K501U gaming laptop that came with an M.2 drive loaded with Windows, plus a 1TB mechanical drive for user data. I swapped out the disk for a Crucial 1TB SSD. The problem is that I like to keep all of my games on the new SSD, and I have a lot of them. Now I'm running out of space.

Should I switch back to a more spacious (but slower) mechanical drive, or buy an external SSD to run my games from?

–Oleg Kravtchouk

THE DOCTOR RESPONDS: As a rule, the Doc avoids tacking on external peripherals to laptops. Toting around an SSD for gaming doesn't sound fun. And dropping back to a conventional hard drive imposes the long level load times gamers try to get away from. Instead, maximize the upgradeability of your laptop's M.2 2280 slot and SATA interface.

Assuming you purchased your K501U with the largest M.2-based SSD option, it's only a 256GB drive. Crucial sells a compatible upgrade with 1TB of capacity. There's also a 2TB model that pops into the 2.5-inch bay, doubling what you have now. Both SSDs maintain Asus's clean lines and, together, yield up to 3TB.



A low-profile GTX 1050 supports lots of display connectivity in quite a compact form factor.

Moving from Microsoft

Dear Doctor, Most of the PCs I own are pretty old, and the main reason I read *Maximum PC* is to keep up to date. I want to build a new system with current hardware soon, but one of the things stopping me is my software options.

I'm annoyed with Microsoft because it basically forced Windows 7 to die out. Among other problems now for Windows 7 is that Internet Explorer 12 has issues with many websites. Edge on 10 appears to run more smoothly, and it's more regularly updated. I use other browsers, of course, but would prefer IE if it worked correctly. In your last issue, you revealed another example of Windows 7 getting the boot: It won't support Kaby Lake. But the main reason that Microsoft wants its customers off Windows 7 (or anything older) is that it wants to please the entertainment and software industry by trying to stop pirating, since torrent sites may reject PCs running Windows 10. My disgust with Microsoft compels me to adopt Linux for my next build. I'm going to try Fedora first and see whether the updates and bugs are tolerable.

On another topic, I find it interesting that *Maximum PC* sees high-end Intel processors as over-priced since the release of Ryzen. Clearly, you don't believe in the saying "you get what you pay for" in this case. Performance benchmarks of the Ryzen 7 1700X and 1800X are pretty impressive, but I'm curious how AMD compares to Intel in areas such as longevity, error control, and so on. Is there any way besides benchmarking to justify Intel's pricing?

–Glen Kussow

THE DOCTOR RESPONDS: Perceived value is relative. Nobody wanted to see Intel's flagship high-end desktop CPU rise from $1,000 to over $1,700, but when Broadwell-E was the only game in town, enthusiasts begrudgingly paid up when those additional cores mattered. Now, power users have a choice, and Intel's premium price doesn't buy you as much extra speed.

Platform maturity plays into some purchase decisions more than others. At launch, Ryzen had issues. But most of them were worked out, and the Doc's Ryzen-based test bed is running fine months later. Only time will tell if AMD built an infrastructure to last. Clearly, though, the definition of value is changing, thanks to AMD.

As far as Microsoft and Windows 10 go, the Doc encourages you to vote with your wallet (though he's getting by well with a VPN and common sense under Windows 10). This may be unpopular sentiment, but it's preferable to see one operating environment developed and protected well than to have engineering resources divided among defending two or three.

Windows 10

CyberPowerPC recommends Windows.
One experience for everything in your life.

Gamer Extreme XT

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NVIDIA® GeForce® GTX 1070 8GB Video Card
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Gamer Xtreme 3000

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THREADRIPPER RE

How to spec up your own crazy video-editing workstation of glory

WE'VE BEEN ALLUDING to this build for a while. The king of all systems—for the next month or so, at least. As processor core counts and clock speeds continue to advance ever onward, desktop performance has increased at an exponential rate this last year. We haven't seen the likes of this since 2010, and it's a joy to witness.

Big blue and fiery red are at it again—CPU Ragnarök has arrived, and with it, a new wave of performance gains, while the battle of the processor gods for market share rages on.

Threadripper brings the very best of server-grade processing prowess to the HEDT (high-end desktop) platform. We're no longer limited by a meager 8 or 10 cores, or PCIe lanes stuck below the 40 mark. X399 represents the finest of what the consumer can get their hands on today. With support for up to 128GB of quad-channel DDR4, the aforementioned PCIe greatness, and a plethora of other neat features, it's currently the go-to platform for anyone who makes a living from the lush green fields of content creation, and ideal for our future plans and development here at *Maximum PC.*

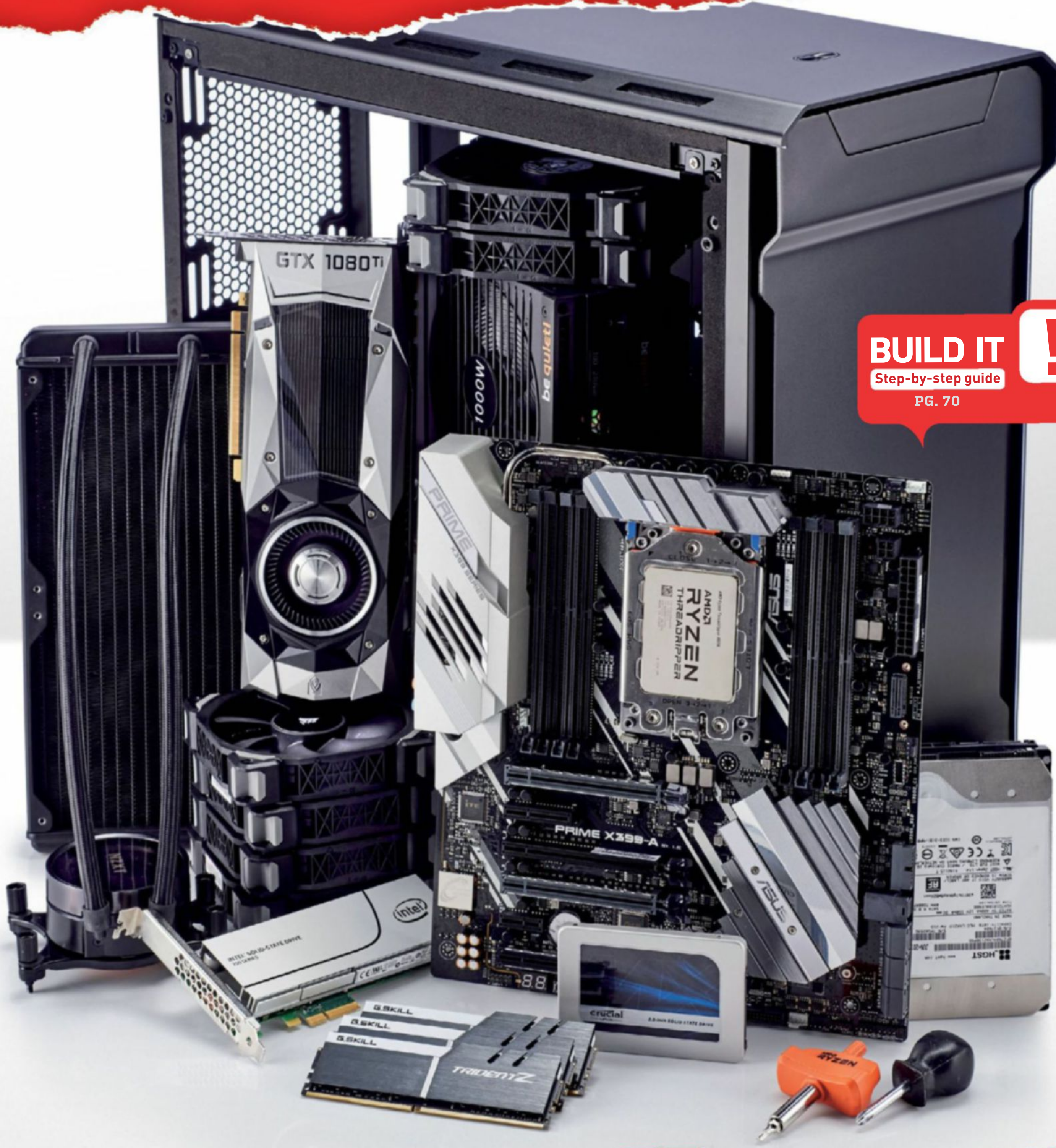
So, what's the sitch? Well, we plan to expand our online digital footprint considerably. Although our team works with *PC Gamer*, we (the print team) feel there's not enough content, nor budget for said content, that caters to our readers, you guys—gaming's nice and all, but it isn't everything. We've been trialing a few things recently, but to further commit to more demanding upload schedules and content creation, we've decided to invest heavily into a rendering rig. With Threadripper launching just last month, it makes perfect sense to take advantage of one of our powerhouses of review samples, and dedicate it to a full-time working machine. And our Threadripper of choice is the 16-core 1950X.

This isn't going to be a cheap system, but given the nature of our work, we can cram it with incredible hardware, which would come with an incredible price tag if we had to pay for it. You can spec out a similar rig for a lot less, and the build process will be almost identical.

THE INGREDIENTS

PART		PRICE
CPU	**AMD Ryzen Threadripper 1950X**	**$1,000**
Motherboard	**Asus Prime X399-A**	**$350**
RAM	**128GB** (8x 16GB) **G.Skill Trident Z DDR4-3200**	**$1,387**
OS Storage	**1.2TB Intel 750 NVMe PCIe SSD**	**$893**
SSD Storage	**Crucial MX300 1.1TB 2.5-inch SSD**	**$345**
Data Storage	**20TB** (2x 10TB) **HGST He10 7,200rpm 3.5-inch HDD**	**$720**
GPU	**Nvidia GeForce GTX 1080 Ti**	**$710**
Case	**Phanteks Enthoo Evolv ATX TG**	**$180**
PSU	**Be Quiet! Power Zone 1,000W**	**$200**
Cooling	**NZXT Kraken X62, 2x Corsair ML 140 Pro,** **4x Corsair ML 120 Pro**	**$280**
Total		**$6,065**

NDERING STATION


GTX 1080Ti
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1000W
PRIME
AMD RYZEN THREADRIPPER
ASUS
PRIME X399-A
intel
crucial
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HGST

BUILD IT !
Step-by-step guide
PG. 70

PROCESSOR $1,000

BUILD IT!
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PG. 70

AMD
RYZEN
THREADRIPPER

AMD Ryzen Threadripper 1950X

IT'S INCREDIBLE HOW far things have come in the last year. Let's take a step back to October 2016 for a moment: Intel's 14nm Skylake architecture was still kicking maximum ass, with its incredible IPC and strong I/O support, and the Core i7-6950X was still the only processor to have made the jump beyond that eight core count—but it came in at a staggering $,1000. AMD, on the other hand, was still lurking around in the world of super-budget FPU and APU rigs, with a convoluted platform and slim pickings when it came to performance.

The rumor mill was in full flow, though, with rumblings of Intel's latest Kaby Lake architecture soon to launch, and the Ryzen hype train getting up to speed. That aside, core count seemed to be resolutely staying put—for the time being, at least.

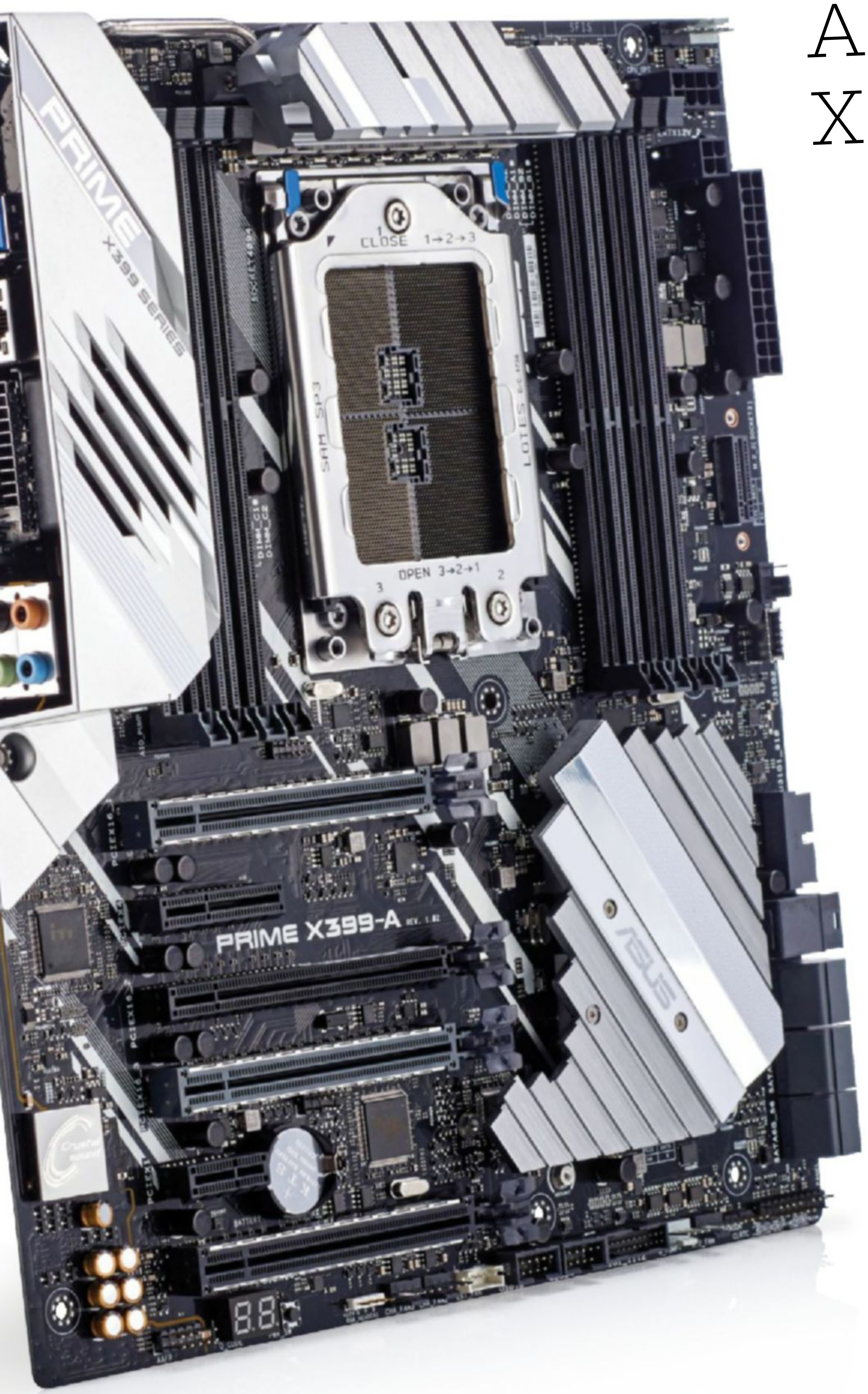
Twelve months later, and the entire ecosystem has changed dramatically. Ryzen was a major game-changer, making eight cores the norm, and demolishing Intel's four-core industry; it's seen both HEDT and mid-range systems change for the better.

The culmination of all of AMD's hard work lies within the beauty that is Threadripper. Needing a competitive platform to rival Intel's X99 series, AMD took a cue from its server-grade EPYC chips, and pulled the entire platform into a consumer-friendly variant. Utilizing half as many cores (so far), and quad-channel support, as opposed to the octo-channel featured in EPYC, team red kept the I/O identical to its server-bound child, leading to a phenomenal 64 PCIe lanes available on every X399 board. Combine that with a staggering 16 Ryzen cores communicating across AMD's infinity fabric, with multithreading, and you're essentially looking at 32 threads capable of operating at a 3.7GHz stock frequency in multithreaded applications. Something even Intel has struggled to achieve so far on its higher end cores.

As though that's not enough, it's even possible to overclock the lot of them. Although we're only talking a small increment of 300–400MHz, when done across all 16 cores, the performance gains are almost unbelievable. Perfect for anyone using demanding processing applications.

MOTHERBOARD $350

Asus Prime X399-A



SPENDING FAR TOO much money on a motherboard is one of the easiest mistakes you can make as a rookie PC enthusiast. It's easy to fall for the marketing slogans, disproportionate bar graphs, and everything else littering a manufacturer's page, and shell out too much on a board that will likely give you just as much performance as one costing $100–200 less than the flagship.

That's not to say there's no reason to invest in a more premium board. I/O is a big deal, and once you start delving into the HEDT platform to look for chunky content-creation machines, it suddenly becomes far more important than any marginal gains you might see in game.

For us, the choice was obvious: the Asus Prime X399-A. With a workstation heritage, solid BIOS, and a plethora of I/O, it fits our build perfectly. We can throw in 128GB of DDR4 memory, connect the three storage devices, install multiple GPUs in the future, and still have room for our 1.2TB combined OS PCIe SSD and scratch disk.

Coupled with its solid BIOS, fantastic on-board audio, and a fairly substantial cooling solution for the VRMs, it's a no-brainer. It also looks stellar. At first glance, when we started to scour the web for an X399 board, we assumed this mobo was coated in white. However, when it arrived, the white turned out to have a gorgeous silver brushed-metal hue to it, covering the north Digi+ Power VRM solution, the rear I/O, and the chipset at the south of the board.

For us, having an accessible and informative BIOS is a huge deal, and there are few BIOSes out there at the same level as that of Asus. Whether it's down to its impressive design team, or the excessive market share the company has, it's so easy to manipulate your hardware, adjust fan curves, and overclock the crap out of anything you need to do on the trusty platform.

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- 16GB Dual Channel DDR4-2400MHz Memory
- 250GB WD Blue M.2 SSD + 1TB 5400RPM Hard Drive
- Full Color Programmable backlight Keyboard
- Intel® Dual Band Wireless-AC 8265 + Bluetooth
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Nvidia GeForce GTX 1080 Ti

THIS IS A DECISION of convenience rather than affordability. You'll struggle to find a Founders Edition of the GTX 1080 Ti for less than 1,000 bucks right now, but you can pick up a stock blower-style reference variant from any of the major brands for just over $700. And it's still easily our card of choice for any high-end workstation.

As proven back in our July issue, although you might get more sway out of a CAD-oriented workstation card from the likes of Nvidia or AMD, the fact is, due to the pure grunt of that GPU working hard at the heart of the GTX 1080 Ti, there's very little everyday consumer content creation that you can't achieve with this beast.

COOLING $280

NZXT Kraken X62 + Corsair ML 120mm & 140mm Pros

DESPITE WHAT you may think, AMD has nailed it with the TDP on Threadripper. Its overall heat output is actually quite manageable, and in our testing, even when overclocked, we've only ever seen highs of 78 C under load, at 4GHz across all cores, over a one-hour testing period. Truly staggering—especially when you consider just how big Threadripper's die is, compared to many of the CPU blocks currently on the market today.

By default, when you purchase your Threadripper processor, you'll get it in its fancy packaging, alongside an AIO mounting bracket, suitable for any Asetek AIO block, and a small torque wrench, to make sure you don't over-tighten your nuts when installing the processor.

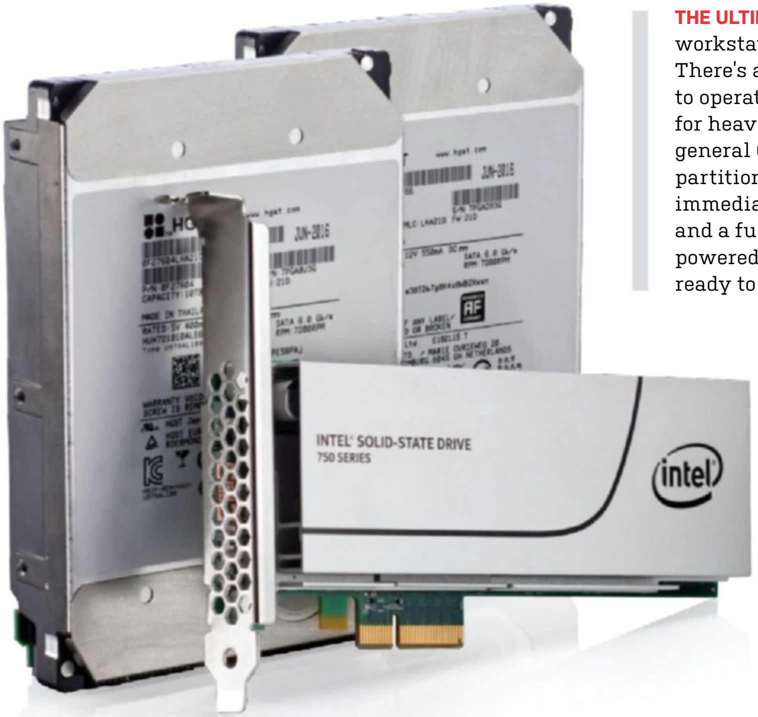
On top of that, we've also thrown in some Corsair ML120 and 140 Pro fans: three 120mm for intake, one 120mm for rear exhaust, and two 140mm in push, exhausting for the Kraken X62.

STORAGE *$1,958*

20TB (2x 10TB) HGST He10 HDD, 1TB Crucial MX300 2.5-inch SSD, & 1.2TB Intel 750 PCIe SSD

THE ULTIMATE combination for any workstation rendering behemoth: There's a 1.2TB PCIe SSD, ready to operate both as a scratch disk for heavy 3D render work and general OS use (with some clever partitioning), a 1TB program and immediate media backup drive, and a further 20TB of helium-powered classic 3.5-inch drives, ready to take the brunt of any local backups necessary for future rendering processes.

The HGST He10 and Intel 750 are both older relics salvaged from our Dream Machine 2016, and will serve this particular system well. Combine that with our publishing company being a Google house, with infinite offsite online backup space, and data security is taken care of.



crucial
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MEMORY *$1,387*

128GB (8x 16GB) G.Skill Trident Z 3,200MT/s

FIRST DEBUTING way back in Dream Machine 2016, our G.Skill kit has been making the rounds in everything from our liquid-cooled builds to the odd Build It project, and has even spent some time in some of our own personal machines. Reason being, it's one of the best kits we've ever seen. And with Ryzen's infinity fabric directly connected to the operating speed of the memory kit you use, it makes sense for us to pack as much high-frequency, high-capacity memory as we can into this build. 128GB gives us a ton of headroom in After Effects, and the 3,200MT/s frequency will keep the core running spryly throughout any rendering challenge we throw at it.

G.SKILL
TRIDENT Z

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CASE *$180*

Phanteks Enthoo Evolv ATX TG

FOR CASE CHOICE, we knew we needed something that could cater for the ridiculous width of that E-ATX motherboard. Unfortunately, due to the vast swathe of VRMs and connectivity that Threadripper requires, the likelihood of finding a true ATX mobo is slim. This, in turn, also limits which chassis you can use, with even the chunky Evolv ATX being a little tighter than we'd like to admit for this build.

That said, it's one of our favorite compact cases, and it supports a wide range of cooling, and support for all the storage we want for this machine. Couple that with the tempered glass and thick black aluminum, and it brightens up the office with its clean, chunky workstation aesthetic, too.

BUILD IT !
Step-by-step guide
PG. 70

PSU *$200*

Be Quiet! Power Zone 1,000W

POWER ZONE
1000W
be quiet!

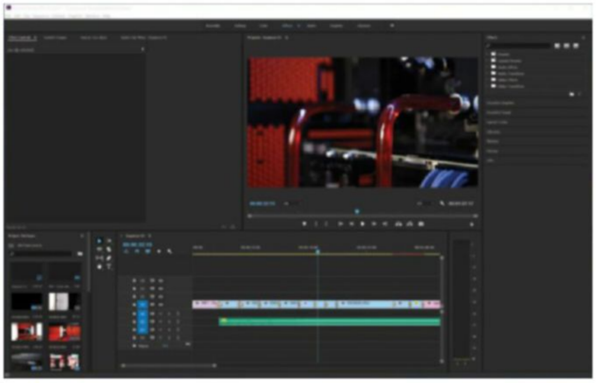
WE DIDN'T GO overboard with the power supply solution this time, instead choosing to pick up this 1,000W fully modular PSU from Be Quiet! It's a perfect fit, coming with simple black cables, and that's about it. No fuss, at a not-so-ridiculous price.

It is, unfortunately, only rated at 80 Plus Bronze, but as this machine is only going to be used in a corporate environment, for which *Maximum PC* doesn't pay the bills, we can get away with that lack of additional efficiency.

That said, our build can draw up to 721W from the wall under absolute full load, so we may be cutting it a little fine if we decide to upgrade in the future—but, in all honesty, the likelihood of needing to go beyond a single-card solution is slim.

ADOBE PREMIERE PRO

Talking specifics



NOW THE "WHAT" has been covered, it's time to get down to the "why." This system's sole purpose is to output 4K video from Adobe's Premiere Pro CC editing software.

We intend to record two or three videos once a week, then schedule them to upload online over a period of time, via either our Facebook page or YouTube, producing anything from teaser system build shoots, to timelapsed content, quick and dirty unboxings, and more. Depending on how that goes, we'll begin to push for more content to go up, eventually up to one or two videos a day.

Premiere Pro is our go-to video-editing software for a number of reasons. Most notably due to its ability to utilize desktop-based hardware on Windows. Apple's Final Cut Pro is more efficient at rendering 4K, but for color correction and ease of use, Prem is the best for the job.

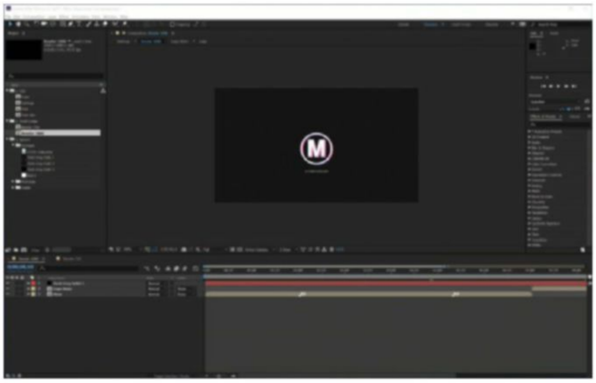
Traditionally, Premiere Pro thrived on CPU power. It wasn't until CS5 that it advanced to 64-bit, to take advantage of more than 4GB of DDR, and finally introduced CUDA and OpenCL support, to better take advantage of GPUs to render content faster and more efficiently.

CUDA is a language that makes the GPU accessible to the programer in a variety of applications. In Adobe's case, that's the Mercury Playback Engine, which lends itself to faster parallel processing computations, faster renders, color correction, higher quality scaling, and more. For us, the best GPU for the job is the GTX 1080 Ti—its mass of memory and the phenomenal number of CUDA cores makes it a surefire bet for improving render times.

And, finally, there's the scratch disks. Premiere allocates a unique scratch disk for each and every project you work on. In short, this is an area of disk space where the Creative Cloud app stores temporary media files while you work. You can choose and allocate exactly where this is in the Settings tab, including the scratch disk's size. Setting it to a large chunk of PCIe storage should help decrease both in-app render previews and the final output render times significantly, when compared to storing your scratch disk on a traditional HDD.

ADOBE AFTER EFFECTS

Making it Flashy



AFTER EFFECTS IS A monster application, capable of everything from the simplest title sequences and credit rolls to more advanced particle effects and other crazy forms of media content.

It's quite daunting at first, but with a few tutorials and a quick YouTube search, you'll soon be on your way to creating impressive intros, transitions, and outros. There's little else like it at the consumer level.

Coming from Adobe, its computational prowess is similar to that of Premiere Pro. However, unlike Prem, which doesn't benefit from access to more memory beyond 16GB, After Effects takes advantage of as much memory as you can throw at it. Adobe recommends a minimum of 2GB per core, HyperThreading aside. So, in a 16-core system like ours, you should have a minimum of 32GB. Extra memory doesn't hurt, though, and once you perform your final render, the more memory you have, the faster you can export your final effects.

Memory is shared between all of Adobe's apps—you can run multiple apps at the same time, exporting from Premiere Pro, applying effects and color corrections in After Effects, and outputting via Adobe's Media Encoder on a schedule, and you can allocate sufficient memory to each app (configurable within each program's preferences). In this case, we're allocating 16GB to Premiere, 96GB to After Effects, and the remaining 16GB of memory to the OS and all our other background applications.

After Effects doesn't use a scratch disk, but relies on a "Disk Cache." Usually allocated to C:\Users\XXX\AppData\Local\Temp, you can allocate this to a specific disk, and increase its size for smoother previews and renders.

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BUILD IT !
Step-by-step guide
PG. 70

THE PERFECT IN-HOUSE UPGRADE

How two years of upgrades can change your working life

THAT'S ONE HELL OF an upgrade. We've gone from 6 to 16 cores, 32GB to 128GB of RAM, and 240GB to 1.2TB of PCIe SSD storage. We've also added an additional 21TB of backup storage, swapped out to a larger motherboard, featuring a butt-load more connectivity, introduced an on-site RAID 1 array, and switched the Phanteks Eclipse P400S TG chassis for the masterfully crafted Evolv ATX TG. Hello, aluminum—boy, we've missed you.

But it's performance that's king here, and performance is what you get with such a crazy upgrade. As this is going to be a personal system update for our reviews editor, testing methodology and system setup are less clinical than with our usual builds. Typically, we do a fresh install of Windows 10, update it, then only install the programs necessary for benchmarking. In that way, no resources are held up by antivirus or superfluous apps, and we can get the best figures out of it.

In this scenario, however, there's a ton of additional programs we need for our day-to-day work, including game clients, cloud sharing, LibreOffice, and a fair chunk of the Adobe suite. And to maintain benchmark integrity, the new build needs to mimic the old one, so we've added a few tweaks to increase performance: Overclocking the CPU to 4GHz (by simply changing the ratio) was our first step, then tweaking the memory DOCP settings (think XMP, but for AMD).

The latter was where we came unstuck. No matter what we tried, using the Asus-supported DOCP 3,200MT/s profile forced the system into a reboot loop, before resetting to default memory settings (2,133MT/s). We got in touch with Asus, and it seems that Threadripper only supports 128GB (8x 16GB) up to 2,933MT/s, at the moment. Whether this is a limitation of the platform or it just requires a new AGESA update from AMD is yet to be established, so for the time being, we're forced to run this kit at 2,933, until support is added.

So, the figures. What a difference! A 230 percent gain in Cinebench, a phenomenal increase in decompression and compression speeds, and a fantastic improvement in real-world benchmarks. Those real-world figures are produced from a one-minute video in Premiere Pro, and a 12-second intro in After Effects; longer projects, particularly in After Effects, would see far more benefit from prolonged access to all 128GB of RAM.

For us, this system is a dream come true, but for the rest of the world, the $6,000 price tag is extortionate. However, a lot of the outlay is on the storage and memory. Given what we know now, by stepping down to a 64GB 3,200MT/s kit, and a more affordable storage solution (a 512GB Samsung 960 Pro, 1TB Crucial MX300 SSD, and two 5TB Toshiba X300 drives), you could bring the price down to $3,700. Still a lot of dollar, but far easier to stomach for a rendering rig.

AMD has again changed the CPU world for the better, and with Intel responding with more affordable and more powerful cores sooner than we thought, it's looking increasingly sunny for consumers. ⏻

BENCHMARKS

	ZERO-POINT	THREADRIPPER BUILD
Cinebench R15 Single *(Index)*	140	160 (14%)
Cinebench R15 Multi *(Index)*	1,020	3,362 (230%)
AIDA64 Memory Latency *(Nanoseconds)*	69.9	104.4 (-49%)
AIDA64 Memory Read *(MB/s)*	53,818	65,833 (22%)
AIDA64 Memory Write *(MB/s)*	49,487	75,572 (53%)
Adobe CC Premiere Pro Render *(Minutes:Seconds)*	2:11	0:56 (57%)
Adobe CC After Effects Render *(Minutes:Seconds)*	1:03	0:39 (38%)
7-Zip Archive Test Compression *(KB/s)*	27,171	55,203 (103%)
7-Zip Archive Test Decompression *(KB/s)*	330,912	1,022,007 (209%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of an Intel Core i7-5820K, 32GB of DDR4-2666, an Nvidia GeForce GTX 1080 Ti, a 240GB PNY CS2030 PCIe SSD, and a 1TB Crucial MX300. All tests performed three times with a mean average taken.

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TAKE IT VIRTUAL

Alex Cox and *Jonni Bidwell* strap on the goggles and enter a world where even hardware goes soft

RUNNING AN OPERATING SYSTEM on real hardware is so passé. All those hours ensuring your hardware is set up and behaving correctly? Pah. Then so many more hours installing and configuring all the software, so everything's just right, while risking what's on the machine already? Ugh. It can seem like an awful lot of effort just to, say, try out a Linux distribution, or create a clean Windows install. And, what's worse, it can present you with a whole lot of extra work if something goes wrong. Killing your day-to-day Windows installation, that one you've spent so long lovingly streamlining and customizing, the one you need for work, play, and everything else? It doesn't bear thinking about.

If you're running a mission-critical system, you also need to figure out a backup strategy, because mistakes and hardware failure both happen. In fact, if you're serious about these things, you'll really want to have something that's as close as possible to a mirror image of that machine, ready to spring into action at the first hint of failure. Even if you're lucky enough to have an identical machine, maintaining such a thing—updates, drivers, software, and all—is monumentally tricky.

Contrast this with a virtual machine (VM). With a VM, you don't have to worry about setting up hardware—any hypervisor worth its salt translates whatever machine it's running on into virtual hardware that your OS can easily understand. You still have to set up the software side of things, but once done, you can replicate the machine at the press of a button, keeping a safe, clean copy for when you need it. You can test out changes by taking a snapshot of the machine and doing your changes there. If the copied VM survives, its parent will, too, as they're identical. However you use your PC, the chances are there's something to be gained from virtualization.

Create
Miami Marlins vs. New York... 1:05 PM
Monday 27
Drawboard PDF
Get Office
Explore
Store
Light Rain
43°
57°
43°
New York
Facebook
sling
Senator seeks ethics probe of Mnuchin's 'Lego Batman'...
News
Ask me anything
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Desktop
Screenshot ...
Settings
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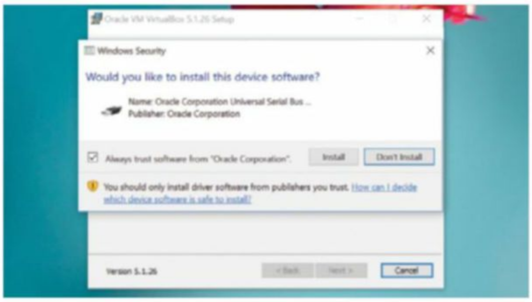
3/28/2017

LET'S START AT THE BEGINNING: The easiest way to get into virtualization is with Oracle's VirtualBox. It's free, open source (barring some extensions that provide USB pass-through), and has a friendly and simple GUI that enables you to set up a virtual machine in just a few clicks. Whether you want to set up a Windows XP VM to practice your hacking skills, fancy trying out a new Linux distro, or even if you want to install something far more weird and wonderful, it's easy and intuitive with VirtualBox. Head to www.virtualbox.org to download the latest version for Windows hosts, and install it on your PC. We're using the latest release of Ubuntu Desktop (download it from www.ubuntu.com/download) to create an example VM, but feel free to download or use any other ISO you may have lying around.

GENESIS OF A VM

Start VirtualBox and click the "New" button at the left of the toolbar. Give your nascent VM a helpful or affectionate name—if you name it something like "Ubuntu-VM," the software even automatically adjusts the "Type" and "Version" settings below, as well as allocating your VM what it considers a reasonable amount of memory on the next page. You can adjust this yourself, but don't go crazy; the more RAM you give over to your guest system, the less the host has to work with.



Would you like to install this device software?

Name: Oracle Corporation Universal Serial Bus ...
Publisher: Oracle Corporation

☑ Always trust software from "Oracle Corporation".

You should only install driver software from publishers you trust. How can I decide which device software is safe to install?

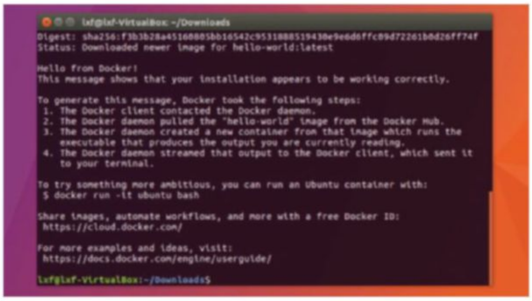
Version 5.1.26

VirtualBox installs several translation drivers on your host system, including virtual USB and networking.

The next step is to create a virtual hard disk, which is a file that will house our VM's data. Choose "Create," and select the default VDI image. In the next step, choose to make it "Dynamically Allocated." This means the file grows as the virtual disk fills, rather than being a big, mostly empty file from the get-go. There's a small performance penalty for this luxury, so you may wish to opt for the more inflexible fixed size option if speed is a big concern; a plain desktop Ubuntu install, for example, occupies less than 4GB, but OSes have a habit of growing over time, and a Windows 10 install would take a lot more space. Make sure you set the top limit of your virtual drive to at least 16GB, or more if you can spare the bytes.

GET UP AND RUNNING

That's it—machine built. You have a VM. But try booting it, and you won't get far, since its drive is currently completely blank. Let's insert a virtual disc and get something installed. Select the machine and click "Settings" on the toolbar. Go to "Storage" on the left, and you'll see that a virtual optical drive (attached to a virtual IDE controller) has been set up as well as our virtual hard disk. Click this, then press the disc



```
Digest: sha256:f3b3b28a45160805bb16542c9531888519430e9e6d6ffc09d72261b0d26ff74f
Status: Downloaded newer image for hello-world:latest

Hello from Docker!
This message shows that your installation appears to be working correctly.

To generate this message, Docker took the following steps:
 1. The Docker client contacted the Docker daemon.
 2. The Docker daemon pulled the "hello-world" image from the Docker Hub.
 3. The Docker daemon created a new container from that image which runs the
    executable that produces the output you are currently reading.
 4. The Docker daemon streamed that output to the Docker client, which sent it
    to your terminal.

To try something more ambitious, you can run an Ubuntu container with:
 $ docker run -it ubuntu bash

Share images, automate workflows, and more with a free Docker ID:
 https://cloud.docker.com/

For more examples and ideas, visit:
 https://docs.docker.com/engine/userguide/

lxf@lxf-VirtualBox:~/Downloads$
```

If Docker offers a "hello world" message, you're all set.

PCI PASS-THROUGH PROBLEMS

TRY TO RUN GAMES or anything else that places any heavy graphical demands on a VirtualBox VM, and you won't have much luck. VirtualBox's 3D acceleration doesn't really do anything for DirectX 10, 11, or 12 titles. There is a solution, but it's one with some pretty heavy requirements. You need to run a Linux distribution as your host OS, and have two graphics cards in your physical machine, one of which you'll use for your host—integrated graphics will do—and the other you'll dedicate entirely to your VM. You also need to have a motherboard with an IOMMU unit, a CPU that supports it, and IOMMU enabled in the BIOS or UEFI. IOMMU is essentially a translation methodology, which maps physical memory addresses between guests and hosts—on AMD machines, you need to look for AMD-Vi, and on Intel, it's Intel Virtualization Technology for Directed I/O, or VT-d. These aren't unusual features for modern boards, but we recommend you check compatibility before you kill off your everyday OS in favor of a Linux host.

From there, it's a not-so-simple process of installing VirtualBox on your host OS (after ensuring it's running a kernel that's IOMMU-compatible), adding in the PCI pass-through extension through the catch-all extension pack, which can be downloaded from www.virtualbox.org, enabling IOMMU in your Linux distro's boot loader (add something such as `intel_iommu=on` to grub.cfg), then using the `lspci` command to check which PCI devices you have attached to your host hardware. The first column lists the PCI address of each device; you can then run a terminal command along the lines of `VBoxManage modifyvm "VM name" --pciattach 02:00.0@01:05.0` to pass, in this case, the device at host address 02:00.0 to the guest address 01:05.0. Complex stuff, but entirely possible if you're determined.

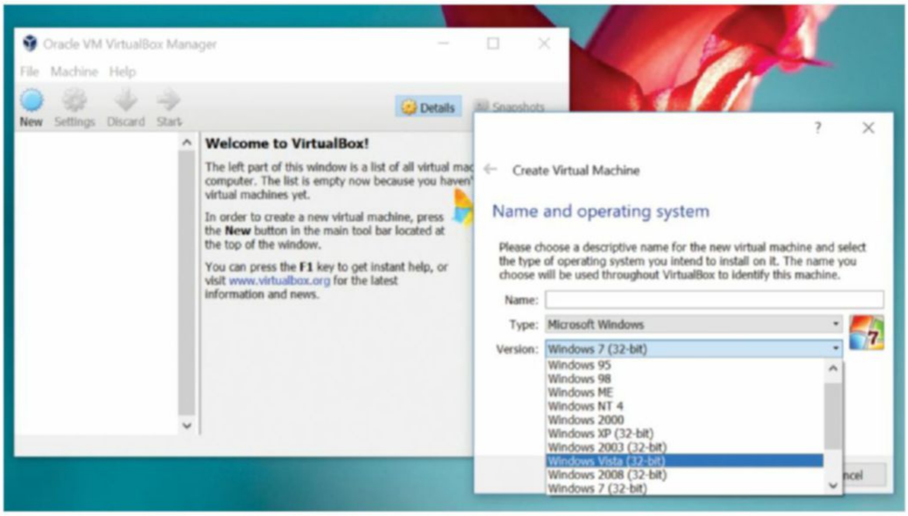
Want to use your GPU to its full effect with a VM? Pass it through....

AORUS
AORUS
GIGABYTE

icon on the right-hand side, and select "Choose Virtual Optical Disk File" from the drop-down menu. Select your downloaded Ubuntu ISO.

Now let's offer up some additional resources. In the "Settings → Display" section of the "Screen" tab, boost the Video Memory to 128MB. Click "OK," and launch your VM by selecting it and clicking "Start." You're now free to install, or play in the Ubuntu live environment, whatever you like, in complete safety—there's no way of doing damage to your main PC, as you're operating in a completely isolated environment. Don't worry about installation specifics—if you decide you want something done differently, it's easy to delete the VM and start over. When the install finishes, the virtual disc is automatically ejected.

One final step to getting things working well: Use the "Devices" menu to insert VirtualBox's guest additions disc into your virtual optical drive, and install the software within. Obviously, this only works for supported guest platforms, but once it's installed, you gain access to neat features such as a shared clipboard and custom dynamic resizing options. You can also, once you head to the "Display" section of your VM's settings, switch on 3D acceleration. It isn't the best—see "PCI Pass-Through Problems" to find out why—but it's a much more pleasant experience than running without it.


Oracle VM VirtualBox Manager
File Machine Help
New Settings Discard Start
Details Snapshots

Welcome to VirtualBox!

The left part of this window is a list of all virtual mac computer. The list is empty now because you haven' virtual machines yet.

In order to create a new virtual machine, press the **New** button in the main tool bar located at the top of the window.

You can press the **F1** key to get instant help, or visit www.virtualbox.org for the latest information and news.

Create Virtual Machine

Name and operating system

Please choose a descriptive name for the new virtual machine and select the type of operating system you intend to install on it. The name you choose will be used throughout VirtualBox to identify this machine.

Name:

Type: Microsoft Windows

Version: Windows 7 (32-bit)

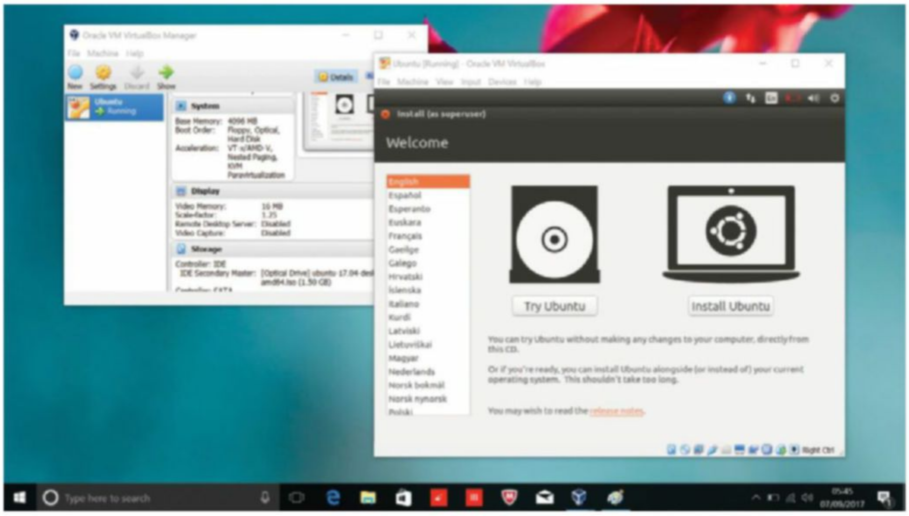
Windows 95
Windows 98
Windows ME
Windows NT 4
Windows 2000
Windows XP (32-bit)
Windows 2003 (32-bit)
Windows Vista (32-bit)
Windows 2008 (32-bit)
Windows 7 (32-bit)
ncel

If VirtualBox only shows options for 32-bit OS installations, make sure virtualization is switched on in your machine's BIOS or UEFI.

SAFETY IN SNAPSHOTS

As we've mentioned, the greatest part about running a VM is the control it gives you over the OS—specifically, the fact that once you've done the hard work of setting one up, you'll never have to do it again. You'll want to use two techniques: wholesale copying of a VM, and snapshotting. The former is reasonably easy. Just right-click a powered-down VM, and select "Clone." VirtualBox creates an exact copy of that VM, which you're free to monkey around with to your heart's content, or set aside for later recovery. A snapshot is slightly different and arguably slightly more useful. It's an exact copy of a running VM, memory state and all, giving you the chance to revert back to a known good configuration if you're about to do something drastic, or to power down your virtual machine and return to the exact point you were at before you quit.

VirtualBox can even handle snapshots in a tree, so you can create several snapshots, fork off in different directions, and keep the same core configuration. You can take a new snapshot at any time by hitting Host-T (your Host key is usually right-Alt), and you're given the option of creating one when you power down a VM as well. These do tend to swallow up hard drive space after a while, so be prepared for a bit of periodic cleanup.


Oracle VM VirtualBox Manager
File Machine Help
New Settings Discard Show
Details
Ubuntu
Running
Ubuntu [Running] - Oracle VM VirtualBox
File Machine View Input Devices Help
Install (as superuser)
Welcome
English
Español
Esperanto
Euskara
Français
Gaeilge
Galego
Hrvatski
Íslenska
Italiano
Kurdî
Latviski
Lietuviškai
Magyar
Nederlands
Norsk bokmål
Norsk nynorsk
Polski
Try Ubuntu
Install Ubuntu
Right Ctrl
Type here to search
05:45
07/09/2017

System

Base Memory: 4096 MB

Boot Order: Floppy, Optical, Hard Disk

Acceleration: VT-x/AMD-V, Nested Paging, KVM Paravirtualization

Display

Video Memory: 16 MB

Scale-factor: 1.25

Remote Desktop Server: Disabled

Video Capture: Disabled

Storage

Controller: IDE

IDE Secondary Master: [Optical Drive] ubuntu 17.04-des amd64.iso (1.50 GB)

You can try Ubuntu without making any changes to your computer, directly from this CD.

Or if you're ready, you can install Ubuntu alongside (or instead of) your current operating system. This shouldn't take too long.

You may wish to read the release notes.

Installing a guest OS installs it entirely to your virtual hard drive, with no risk to your host PC.

GO SELF-CONTAINED

Let's take a step back now. For all the benefits they offer, every new VM spun up means a new copy of an operating system. This means lots of duplication of data and effort. A virtual OS still takes time to install, and even though this can be automated to some extent, most VMs still take some configuring before they're useful. And if you're using a VM for a single task, this is, frankly, a bit of a waste of time and system resources. But there's a more streamlined way of isolating applications and services, without installing a whole new OS, enabled by the idea of containers. These give some access to the host OS, but drastically restrict access to anything that might break it, and enable applications to be deployed in a uniform way on any OS. Any sysadmin who's had to migrate an old webapp to new infrastructure will know the special sort of pain this can avoid.

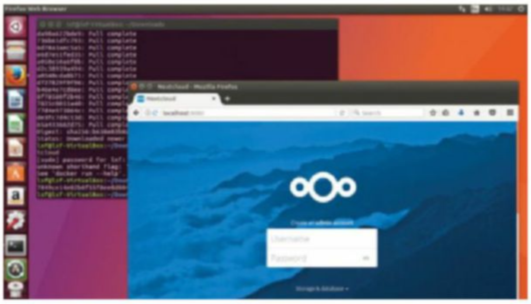
The de facto king of container management, widely used and therefore widely supported, is Docker. Thanks to the Docker Hub, it's possible to download a community-generated image of an email server, a NextCloud instance, a NAS appliance, or an MPD server, say, and have it running in a matter of seconds. Docker's Community Edition (the one we're using here) is freely downloadable, and available for Windows 10 Pro and just about every Linux distro—but bear in mind that this means it's not compatible with Windows 10 Home, the version most people are running. With this in mind, we'll show you how to use its Linux flavor through Ubuntu—simply download and install the Community Edition from www.docker.com/get-docker, then replicate the commands here, cutting out the "sudo" parts, in a Windows PowerShell window, and you shouldn't run into too many problems.

DOCKING FOR BEGINNERS

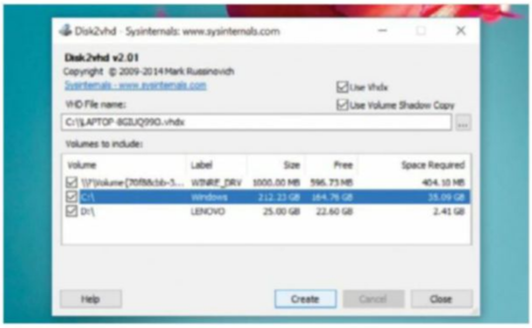
Let's start by installing Docker on Ubuntu. While it's possible to install through a command-line package manager, setting up the requisite repositories is a little long-winded. Instead, head to https://download.docker.com/linux/ubuntu/dists/ and grab the latest stable version for your system—you'll find a .deb package within the requisite /pool/ folder. Download it, rather than open it in Ubuntu's software installer. Open a Terminal window, and head to the directory where you downloaded the package (typically ~/Downloads). Type `sudo dpkg -i docker` then, before hitting Return, hit Tab to complete the name of the package you just downloaded. Hit Return, and the installation should happen. Let's check that it did: Fire up the Docker daemon with `sudo systemctl start docker`, then run `sudo docker run hello-world`. All being well, this pulls in a sample script and executes it—if you see a cheery message, you're good to go.

Time to install something that does more than just display a message. Run `sudo docker pull nextcloud` to grab a container encapsulating everything required to run a NextCloud file server. At 700MB, it's fairly large, but bear in mind the NextCloud app is 100MB, plus we've got Apache, PHP 7, and a bunch of extensions, along with the SQLite database packaged in with it, all ready to go. Run the container with `sudo docker run -d -name maxcloud -p 8080:80 nextcloud`. The "-d" option tells Docker to run in the background (detached), and the "-p" part forwards port 80 on the container to port 8080 on our host. The "-name" part is optional; a random one is assigned if you don't specify one here.

Assuming that command didn't give you any error messages, fire up your web browser, and browse to http:// localhost:8080. Behold! A fully functioning NextCloud installation—no messing with Apache configuration files or directory permissions, it just works. All you need to do is enter some admin credentials and click "Finish Setup." When you stop the container



With only a couple of commands, you can install and run an entire preconfigured Docker VM appliance.



Disk2vhd - Sysinternals: www.sysinternals.com

Disk2vhd v2.01
Copyright © 2009-2014 Mark Russinovich
Sysinternals - www.sysinternals.com

☑ Use Vhdx
☑ Use Volume Shadow Copy

VHD File name: C:\\LAPTOP-8G2UQ99O.vhdx

Volumes to include:

	Volume	Label	Size	Free	Space Required
☑	\\?\Volume{70f88cbb-3...	WINRE_DRV	1000.00 MB	596.73 MB	404.10 MB
☑	C:\	Windows	212.23 GB	164.76 GB	35.09 GB
☑	D:\	LENOVO	25.00 GB	22.60 GB	2.41 GB

Fortunately, cloning a drive with Disk2vhd is a relatively straightforward process.

GOING BEYOND VIRTUALBOX

WE'VE COVERED VIRTUALBOX in detail, primarily because it's free to use and pretty comprehensive in its abilities. For most tasks, you're unlikely to need anything more complex. If you want to take virtualization further, though, there are a few commercial tools that can make the process easier and (generally) run VMs more efficiently. VMWare Workstation Player, free with a limited set of features, is a solid option, and one that's compatible with the same VHDs, though you need to pay a license fee if you want to use it commercially. Its level of support and development is, naturally, very good, it's arguably more capable than VirtualBox, and it's due a major version upgrade soon, which should add a little spice. Check it out at www.vmware.com.

If you're willing to create a dedicated host, it's also worth considering Linux-based solutions. QEMU (www.qemu.org) is available for just about every Linux distribution, and it's super-efficient, executing as much of the guest code as it can directly on the host machine, through a process known as dynamic binary translation. It's also able to run without admin privileges, meaning you can tuck your QEMU VMs away on a flash drive, carry them around with you, and return to a familiar environment no matter which host machine you're running on. There's a version compiled for Windows, if you're feeling adventurous—see http://qemu.weilnetz.de for the downloads.

While we're in the Linux world, picking a distro based on the Xen hypervisor is a good choice for experimentation. Check out Qubes OS (www.qubes-os.org), which dubs itself "a reasonably secure operating system" with a typical lack of hubris. All of its apps run in one of a number of VMs, completely isolating them from the others for security and efficiency reasons, and you can add your own VMs—including those based on a number of different Linux architectures and, naturally, virtual machines based on Windows.

What is QEMU?

QEMU is a generic and open source machine emulator and virtualizer.

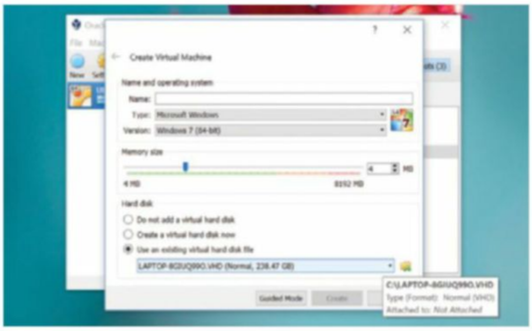
DOWNLOAD
CONTRIBUTE
DOCUMENTATION
BLOG
Full-system emulation
User-mode emulation
Virtualization

with `sudo docker stop maxcloud` , any changes are saved, unless the underlying image is upgraded, so you can resume it as it was with `sudo docker start maxcloud` in future. Note: We use our container name, rather than the image name (nextcloud), because the latter would fire off a new, unconfigured NextCloud instance.

PHYSICAL TO VIRTUAL

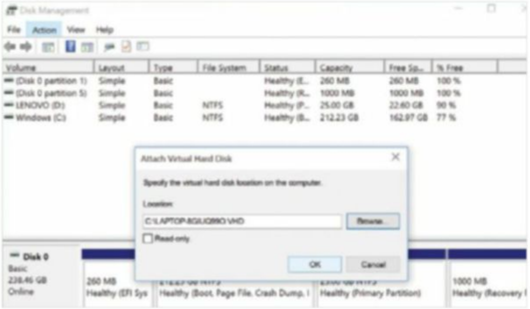
As you've got this far, you're probably starting to appreciate the value there is in virtualization. But there's one more thing we haven't touched upon, and that's consolidation. One machine with a number of virtualized instances running on it can do the job of several physical units without the need for any extra hardware. If you're in the mood to replace that old file server and trash that Win XP box that really should have been recycled 10 years back, there's good news: You don't need to completely rebuild those systems in a virtual environment. You can convert their hard drives to virtual drives, and fire them up in VirtualBox as though they were newly created VMs.

Note that this does come with a couple of downsides, namely that Windows may need a little poking before it accepts your new virtual hardware, and that you'll almost certainly invoke a new activation of your Windows key when you fire up its virtual version—major hardware changes tend to do that, so you need to erase the old hardware, and perhaps contact Microsoft to arrange reactivation. Note also that transferring an OEM installation of Windows to a virtual instance is a violation of the terms and conditions of installation, so you're unlikely to get much assistance in this case.



Name and operating system
Name:
Type: Microsoft Windows
Version: Windows 7 (64-bit)
Memory size: 4 MB
Hard disk
○ Do not add a virtual hard disk
○ Create a virtual hard disk now
● Use an existing virtual hard disk file
LAPTOP-8GIUQ990.VHD (Normal, 238.47 GB)
C:\LAPTOP-8GIUQ990.VHD
Type (Format): Normal (VHD)
Attached to: Not Attached

Use Expert mode to quickly attach a cloned drive to a new VM in VirtualBox.



Volume	Layout	Type	File System	Status	Capacity	Free Sp...	% Free
(Disk 0 partition 1)	Simple	Basic		Healthy (E...	260 MB	260 MB	100 %
(Disk 0 partition 5)	Simple	Basic		Healthy (R...	1000 MB	1000 MB	100 %
LENOVO (D:)	Simple	Basic	NTFS	Healthy (P...	25.00 GB	22.60 GB	90 %
Windows (C:)	Simple	Basic	NTFS	Healthy (B...	212.23 GB	162.97 GB	77 %

Attach Virtual Hard Disk
Specify the virtual hard disk location on the computer.
Location:
C:\LAPTOP-8GIUQ990.VHD
☐ Read-only

Disk 0
Basic
238.46 GB
Online

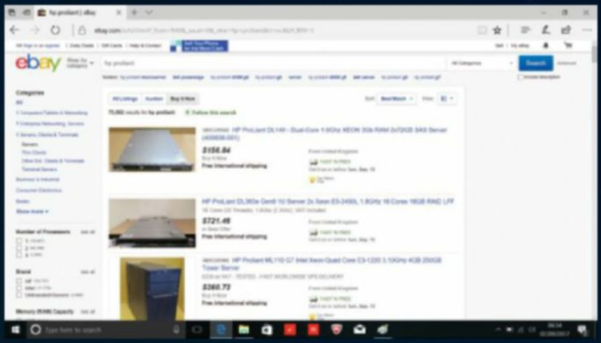
Try attaching a VHD using Disk Management—you can also create VHDs with this tool.

To convert an existing installation, we recommend using Disk2VHD, a tool from Microsoft's Sysinternals team. The process is really pretty simple. Download Disk2VHD from http://bit.ly/2wILzb4 and run it. Define the file name you want to give to your virtual drive, and pick the volumes you want to clone. Disk2VHD leaves your partition tables intact, but you can exclude the data of certain partitions if you want to keep the size down. Switch off VHDX, hit "Create," and Disk2VHD uses Windows' own Volume Snapshot tools to create a byte-by-byte copy of your chosen drive. When it's done, fire up VirtualBox, make yourself a new VM with the appropriate parameters for your cloned OS, then enter Expert mode, and select your .vhd file in the bottom box. Boot, and you'll be away—don't forget to install the Guest Additions for the best experience. Oh, and one more thing: Did you know you can mount VHD files natively in Windows using the Disk Management tool? There's something to try.... ⏻

SERIOUS VIRTUAL MACHINES

IF YOU BEGIN TO RELY on virtual machines to a serious extent, enterprise-grade solutions are probably worth a look. The industry standard for virtualized servers is VMWare's ESXi tech—available free in a package called vSphere Hypervisor—and Microsoft also offers up its Hyper-V Server 2016 without charge. Both solutions run a similar model: a complete hypervisor running at the OS level, and nothing else. In the terms we've used in this feature, they're your host operating systems, but they do nothing more than host, giving their guests unprecedented access to system hardware, and giving you high-level access to the administrative tools you need to maintain a server full of temperamental yet critical systems. Typically, home users boot the likes of ESXi from a small local drive, such as a USB stick or an SD card, with VMs stored on mass storage devices elsewhere.

As you might expect, running server-class software generally requires running server-class hardware to match. Of course, you're free to install vSphere Hypervisor on a USB stick and attempt to run it on hardware you may have on hand, and we've certainly heard tales of it working, though this isn't incredibly likely, unfortunately. Luckily, the unstoppable march of progress means that businesses are constantly upgrading their equipment, meaning you can often grab suitable rack-mount hardware for a fraction of its original cost if you shop around on eBay. Naturally, your power bill will rise, they're noisy and hot as all hell, and you'll need somewhere to put it, but a dual-CPU Xeon system, packed with RAM, could cost as little as $150 if you're lucky enough to find one locally. Check the compatibility list at www.vmware.com/resources/compatibility to see whether you're likely to be able to easily fire up a set of VMs—and then check your wallet, because playing home sysadmin can be an expensive hobby.



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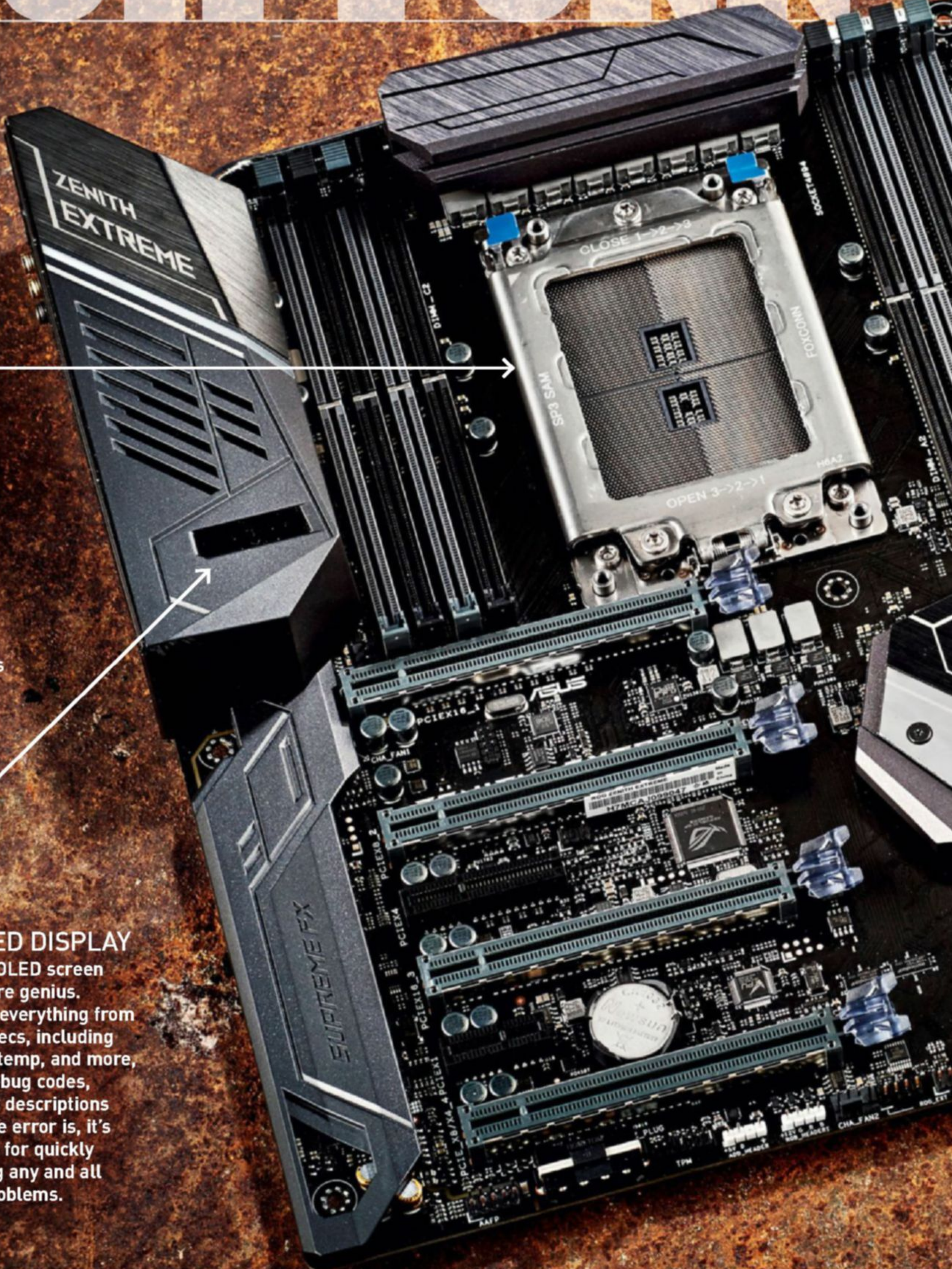
TECH PORN


ZENITH EXTREME
SUPREME FX
CLOSE 1->2->3
OPEN 3->2->1
SP3 SAM
FOXCONN
SOCKET4094
PCIEX16_1
PCIEX8_2
PCIEX4
PCIEX16_3
PCIEX1
AAFP
TPM
CHA_FAN2

1 TR4 SOCKET

The TR4 socket is both LGA and terrifying. Requiring a Torx screw to undo, sliding the Threadripper chip into place in the inner bracket, over the top of those 4,094 pins, is enough to set anyone's hair on edge. But access to all of those 16 cores is well worth it.

2 OLED DISPLAY

The OLED screen here is pure genius. Featuring everything from system specs, including GHz, CPU temp, and more, to BIOS debug codes, along with descriptions of what the error is, it's invaluable for quickly diagnosing any and all system problems.

3 M.2 DIMM SLOT

This isn't the first time we've seen an integrated DIMM M.2 slot on an Asus mobo. This custom DIMM supports an add-in card that enables you to install an additional two M.2 PCIe SSDs across the DDR4 interface. They still operate at PCIe 3.0 x4, but it's a neat idea, because it gives both M.2s better access to cooling solutions.

Asus X399 ROG Zenith Extreme

HOW DO YOU define "enthusiast"? It's a question we ask a lot, because it's challenging to keep ourselves on track. It's all too easy to go with the expensive, like the Hellcats and the Ferraris of this world, as opposed to the affordable. The unattainable is often the most desired. And as brands push their halo products on to us to showcase to the world, in an effort to secure an engineering reputation for the rest of their lineups derived from higher up, it's all too easy to become distracted by the glitter and the glam.

For us, however, the term enthusiast means more than that. It's more than whether you can afford whatever component you desire. It's about how passionate you are for the work you produce, the content you create, the hobbies in which you partake, and the community of which you're a part.

Threadripper belongs very much in that echelon. It's designed to wow, and to be used by professionals. And with it comes a plethora of high-end motherboards, all designed to take advantage of the monstrous connectivity and performance associated with those eight cores and beyond. And the best of the bunch? Asus's ROG Zenith Extreme. The pinnacle of what you can achieve on a motherboard for performance, connectivity, and aesthetics, it's nothing short of a dream. **–ZAK STOREY**

4 RGB FOR DAYS

Of course, it wouldn't be a high-end board without integrated RGB lighting. As much as we despise the latest trend, we have to admit that the subtle lighting found within both the chipset and the rear I/O cover lends itself well to the overall premium feel of the board.

The blockchain and the Internet have spawned cryptocurrency, and it's here to stay

THE RISE OF NEW MONEY

On January 3, 2009, a programer (or programers) working under the pseudonym Satoshi Nakamoto launched something remarkable: a new form of money, a digital cryptocurrency called Bitcoin. The idea was that Bitcoin would be completely independent of outside forces—no banks, no governments. It would be a distributed method of wealth that required no trusted third party to verify transfers or hold money. Supply was limited, to combat inflation. A simple idea done with clever math.

Cryptocurrencies run on a peer-to-peer system. Transactions take place between two parties without intermediaries, verified by horribly involved calculations. This math is based on public-key cryptography; put very simply, each transaction is verified by the completion of a series of cryptographic puzzles, and added to the blockchain. The blockchain is the ledger, which is distributed and checked by the network. To reward those who do the hard work of maintaining the ledger, they are paid in coins—as you "mine," you run the network.

The math may be complex, and the concept big, but in use, it's fairly easy. Create a wallet with public and private cryptographic keys, and you can buy and transfer coins. At first glance, there's one clear problem: no collateral at all. Bitcoin is built on sand and trust, yet it works....

WWW.GOLDBITCOINSHOP.COM

A novelty gold-plated version of the Bitcoin—there are a good few of these about. Worthless, but it provides something to photograph for Bitcoin articles, at least.

Enthusiastic early adopters got the Bitcoin gears turning, but the initial value of the coins was negligible and negotiable, and they were traded between friends. The first cited proper purchase was in May 2010, for two pizzas, at a cost of 10,000 coins.

In July 2010, a Bitcoin was worth eight cents. By early 2011, it achieved parity with the dollar. Early this year, it reached parity with gold. Since then, it has gone well beyond that. As we type this, a Bitcoin is worth $4,159. Those pizzas cost the equivalent of over $41 million today. While that quick calculation was being made, Bitcoin jumped to $4,202, and then back to $4,130. Valuable, but also terribly volatile. There have been some spectacular slumps along the way, the value halving or worse a number of times.

Money is trust, and to be worth anything, it must be transferable to goods or other currencies. At first, you would have to talk a merchant into accepting it; now, Bitcoin has reached a turning point, depending on where you are in the world. It is not fully integrated with the banking system, or even legal tender, yet it can be spent.

The United States Department of the Treasury classifies cryptocurrencies as virtual currencies, and therefore not under its remit; however, their generation counts as money transmitters. Last year, a federal judge ruled that Bitcoins are "funds within the plain meaning of the term." So, it is money. In China, individuals can trade in Bitcoins, but the banks cannot.

Elsewhere in the world, it ranges from being completely illegal to being widely accepted as money. Generally, it is treated as "private money," not legal tender, but is still wealth, and subject to the same taxation. One acid test for money is whether you can pay your taxes with it. That next step has been taken. From April this year, Japan started counting Bitcoin as legal tender. Russia, Germany, and others reportedly have plans for similar steps. Bitcoin is on the verge of going fully legit. Full government approval inevitably leads to regulations at some point, or attempts, anyway.

FINANCIAL STABILITY

Until legislation fully catches up with cryptocurrencies, you are operating largely outside the traditional financial framework, and therefore the legal protection of the central banks and governments. You are pretty much on your own if things go wrong. Don't panic, though; Bitcoin has amassed enough adherents to be respectably stable.

Another acid test for money is whether you can swap it for other money, preferably the green folding kind. To do this, you need to go to a Bitcoin exchange. There are some 64 of these worldwide, and levels of security, privacy, and control vary. Over the years, a number have had their security breached, gone bankrupt, or, in at least one case, simply disappeared with all the funds. This is where that democratic and distributed—and hence loosely regulated—aspect of cryptocurrencies can look worryingly fragile. Some research is recommended before you start making large transactions. Scary? A little, but the cowboys are rapidly being weeded out.

The days of these unregulated exchanges may well be numbered, anyway. Becoming legal tender opens the way for the traditional financial institutions to start trading in Bitcoin. Increasingly, it is becoming yet another cog in the wheels of international business. This summer, the Swiss bank Falcon added Bitcoins to its accounts—customers can now buy and hold them in their own accounts. At the end of August, this was expanded to Ether, Litecoin, and Bitcoin Cash, too. Amazon, Apple, and Google are all working on integrating Bitcoin services. Widespread adoption is coming quickly.

Meanwhile, there are more than a few technical problems to deal with. The increasingly technical complexity of transactions has begun to drag. Currently, a Bitcoin transaction takes about 20 minutes to process; occasionally, an hour or more. On smaller deals, merchants often ignore this, and take the payment on trust—if you are buying a fancy new watch, you'll probably have to wait.

This, along with the attendant meager results when mining, has helped spark a bit of a civil war in the Bitcoin camp, which led to it being split in two. A clone of Bitcoin was created—Bitcoin Cash—which altered the math to allow for much faster transitions. A software update is also due this fall—Segwit2x—aimed at addressing the speed issue as well. This is also causing conniptions, and a second split is in the air. Changes to the underlying code have huge effects on the whole edifice.

The decentralized nature of Bitcoin was designed to ensure no single failure would have much impact, and no single player could dictate terms. That has been eroded considerably now; huge swathes of the

TOP CRYPTOCURRENCIES YOU CAN MINE

Bitcoin was the first and is by far the largest cryptocurrency, with a market capitalization of $70-odd billion. However, it has spawned many more, and these are the current biggest alternatives. Values here are, as ever, volatile as anything.

ETHEREUM

Launched in 2015 and subject to huge recent growth, Ethereum is currently worth about $28 billion. It uses a scripting language that can be executed over the network, making it a platform for other applications.

BITCOIN CASH

Split from Bitcoin earlier this year, Bitcoin Cash's coins are currently under 10 percent of the value of the originals, worth $4.9 billion as a whole. It uses a larger block size to increase speed.

LITECOIN

Worth over $2 billion, Litecoin is technically very similar to Bitcoin, although tweaked to be faster—transactions are currently about four times quicker. It was launched in 2011, which makes it one of the old-timers.

DASH

Worth about $1.7 billion, Dash is similar to Bitcoin, but uses a two-tier structure of miners and masternodes, with a decentralized governance.

MARCO KROHN: CREATIVE COMMONS

This is why your desktop can't mine Bitcoin effectively anymore. This mining farm in Iceland is your competition.

network run in large data centers. Salcido Enterprises is building a data center in North Washington that will consume 7.5MW of hydro-electric power. Going further up the scale, in Xinjiang province in China, a major player called Bitmain is building a data center that will consume up to 135MW of power, and Bitcoin mining will be its main job. Bitcoin has come a long way from its hobbyist roots.

Bitcoin has an intrinsic limit of 21 million coins, which is expected to be more or less reached by around 2040, although it'll take a lot longer to mine the very last block. What happens then could be awkward. By this point, the complexity of the blockchain will be considerable, and there will be no new coins to pay for running things. Transaction fees at some point look inevitable.

As a cryptocurrency "matures," it increasingly falls under the control of those with the computing power to run it. Control over the supposed democratic and distributed currency gathers around the big data centers and the exchanges. It's an old story: The "kids" come along with something cool, and the "suits" take it away, commercialize it, and sell it back. Man. However, digital money's full integration into mainstream financial markets is hampered by its very nature. The markets like centralized exchanges and institutions, and don't like volatile currencies.

VOLATILE VALUE

Rapid changes in value are not too much of an issue when ordering pizza, but a corporation making a big international payment won't like to see percentage swings in value of the currency used over the minutes or hours it takes to verify a payment, which could be millions of dollars either way.

The central concept of the blockchain is proven, though. A number of currencies have been created that cannot be mined, but concentrate on the business of transfers. They launch with a fixed number of tokens. The biggest of these is Ripple, currently worth over $6.1 billion. The aim is similar to Bitcoin: seamless and easy transfers of any currency to anywhere else, with no third-party fees or involvement. It positions itself as a complement to, not a rival of, Bitcoin. Transactions go through in seconds, which alleviates the problem of the currency's value bouncing around too much. It's designed specifically with banks and business in mind, citing better security and scalability than Bitcoin and its ilk. You can trade in these business-orientated cryptocurrencies on the exchanges,

ETHEREUM CLASSIC

This was born out of a fork of Ethereum after the DAO Ethereum spin-off project had $50 of its Ether tokens stolen. The Classic is the original Ethereum blockchain, and is worth about $1.3 billion.

BITCONNECT

A newcomer, launched in February 2016, BitConnect has seen huge growth since, with coins jumping 1,800 percent in six months, and currently worth $765m in total. BitConnect includes the facility to earn interest on lent coins.

MONERO

Based on different technology to Bitcoin and a fork of Bytecoin, Monero experienced huge growth thanks in part to its use on the darknet market AlphaBay (now defunct). Currently worth about $765m.

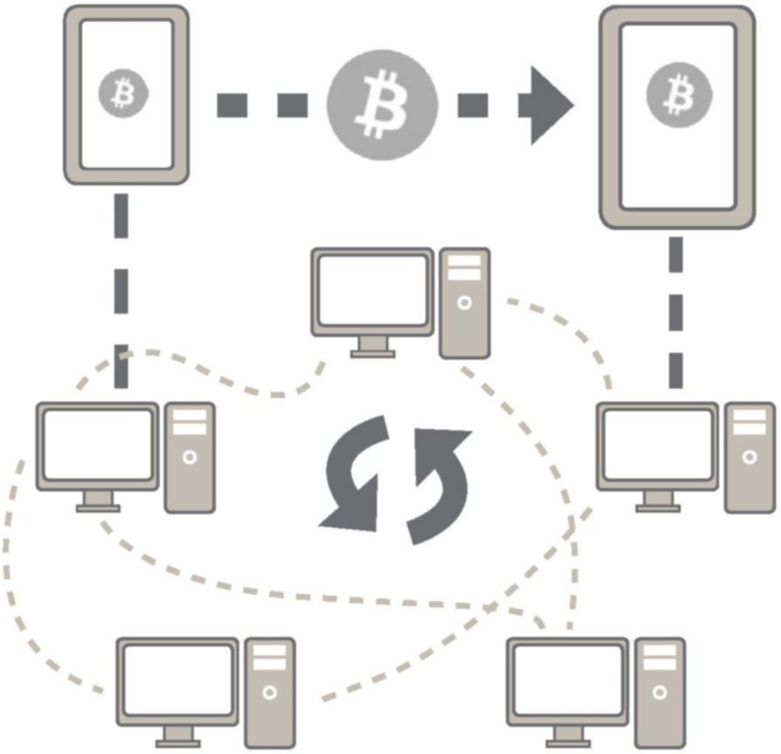
ZCASH

Under a year old and already worth $452 million, Zcash's blockchain can hide the amounts and recipients, or make selective disclosures to third parties—useful for complying with money-laundering or tax regulations.

BYTECOIN

Not to be confused with Bitcoin (BCN versus BTE). The first currency based on the CryptoNote protocol, which is behind a number of coins. Old for a cryptocurrency, it's been around since 2012, and is currently valued at $255 million.

THE BLOCKCHAIN



It's a little complicated. And it should be—it's cryptography. Every requested transaction is packaged into a block with a timestamp, and broadcast to every machine on the network, the nodes, to be verified. Once it is, the transaction goes through, the block is added to the chain, and all nodes are updated with the new longer chain. This blockchain is essentially a list of transactions.

To verify a transaction, the chain must be checked to ensure sufficient coins have been added to your account to cover the output. These are then not considered valid for future transactions. Coins are kept in a wallet application, protected by cryptographic keys—one public, one private. Your transaction is encrypted using your private key and the recipient's public one, to ensure only they can receive it, and they know it's from you

Before a block can be added to the chain, each must contain the answer to a complicated math problem, created using a one-way cryptographic hash function, which essentially turns input into a mass of tangled data. To unlock this requires the network to guess a number which, combined with the previous block, gives the correct answer. Thus, each block is cryptographically locked to the previous one.

These puzzles take considerable power to unlock. To reward those who go through the hard work, successful solutions receive Bitcoins. Each block can contain multiple transactions, limited by the block size: currently 1MB, with typically 1,700 transactions for a Bitcoin. The difficulty level is periodically recalculated, to ensure security is maintained, and that each block takes about 10 minutes to process. Every four years, the block reward is halved—it's currently 12.5 coins.

Security is tight. Nodes only accept the longest verified chain, and any erroneous block quickly disappears. To force the system to accept a modified transaction would involve taking on the combined mathematical power of all the nodes. Blockchain technology isn't limited to cryptocurrencies; coins can represent anything, such as shares, copyright registrations, digital identities, contracts, votes, or anything else you want to keep on a secure verifiable ledger. Or the tokens can be the data itself—distributed secure cloud storage is being worked on. You are going to hear a lot more about blockchain apps.

but there's none of the fun of mining, or watching values bounce around.

Mining coins offers the tantalizing prospect of "free" money, and it's this aspect of cryptocurrencies that catches the eye of many. Fortunes made by adopters of the first currencies have fueled a healthy interest in new launches. Getting in early is key: Hit on a coin that rises, be one of the first to mine, and you're a millionaire in days. Yeah, well, probably not. It's not 2012 anymore, and anything that looks to have a chance of being remotely successful has serious computing power thrown at it in short order. Despite what the sellers of mining machines may say, it is a tenuous business to run on a small scale, unless you hit the right vein.

LOSING MONEY

Any cryptography can be broken. The early years saw a number of large losses. In 2014, 650,000 coins were stolen from what was at the time the biggest exchange—Mt. Gox, in Japan—leading to its bankruptcy, and the halving of Bitcoin's value. Technology is improving, but there will always be the shadow of hacks, as there is in all electronic banking systems, generally originating from inside the company. The foundations of Bitcoin have proved to be robust enough to survive early glitches, though.

As with any digital property, duplication is easy. If there can be one, there can be many. There are currently over 600 cryptocurrencies, and frequent new launches. Their values drop as you scroll down the lists, from Bitcoin's billions to virtually nothing for new contenders. There's Titcoin, which is, ahem, designed to pay for "adult services." And PotCoin, which is, well, you guessed. Others are just plain scams. At the bottom of the market, it's like a frontier town out west: wild.

Last year, one of the senior Bitcoin developers, Mike Hearn, rather publicly left, and told the world why. He claimed it was a "failed experiment." He bemoans the fact that, while founded on libertarian principles, Bitcoin was effectively controlled by five people who have the authority to change the source code, and that there was much dissent between them. The other problem he cited were the big miners: 95 percent of the network is controlled by a handful of people with big data centers. "The fundamentals are broken, and whatever happens to the price in the short term, the long-term trend should probably be downward."

His points about the control of Bitcoin are valid; his prediction on price is anybody's guess. However, Bitcoin is increasingly looking to be a solid bet in the long term. A number of big players have made considerable investments in cryptocurrencies: venture capital names and hedge fund managers, through to key figures in the tech business.

Snapchat's Jeremy Liew went as far as postulating a Bitcoin value of $500,000 by 2030. If that sounds optimistic, he is not alone. Facebook's Chamath Palihapitiya said that "it's the ultimate insurance policy against autocracy, currency curbs, and other forms of value destruction." The digital version of gold under the bed, in case all else fails. Cryptocurrencies are popular in countries that have experienced financial disasters, such as hyperinflation, or have lived under oppressive governments. Not quite what its originators had aimed for, but still. Big names invite confidence, and it's this that keeps Bitcoin and its friends afloat. Bill Gates believes in it, and that's good enough for most.

Predictions of any authority on the cryptocurency market in the short term are next to impossible. It is young and volatile, and we can expect more spikes and crashes along the way. As markets mature, they tend to coalesce. Many smaller currencies will fade. Can Bitcoin make it? In one form or other, probably. Most likely as an investment unit; it's just too slow in its current form for everyday money transfers. It may not remain the main player, but it's attracted enough investments to ensure it can survive pretty heavy weather.

There are some terribly enthusiastic supporters for Bitcoin. They talk of a revolution, of values hitting $250,000 a coin by 2020. A tantalizing possibility. Given its limited supply, it would take much investment capital moving from gold or shares into Bitcoin to send values skyward. It has reached a point for many where a coin or two in a balanced portfolio is well worth considering. Bitcoin cannot be manipulated by governments; you cannot simply create more. Soon it will be readily tradable for goods and services, and be part of the monetary system. Then you may well be glad you have one. There are issues, which Mike Hearn highlighted. It may be free from government control, but it is still under control, and currently by a rather small group. There are interesting times ahead. Yes, Bitcoin could crash and burn, but so can any monetary system.

It's clear that digital currency is here to stay. To those raised on hard cash and checkbooks, cryptocurrencies look odd. There's no collateral, nothing underneath. But the genie is out of the bottle, and our kids won't know a world without them. Meanwhile, there's one clear winner: Satoshi Nakamoto. He/she/they mined a lot of the early coins, a million or so.

MINING COINS

Asus's forthcoming B250 Mining Expert board will offer a staggering 19 expansion slots, in order to fit as many GPUs as possible in a single system.

Cryptocurrency mining has recently led to a scarcity of certain graphics cards, such as AMD's Radeon RX480.

ASIC machines do the majority of mining now. This is an Antminer S9, capable of 13.5TH/s. The other product is heat. Serious farms need air conditioning—or, better yet, they operate near the Arctic Circle.

Mining Bitcoins means running the SHA256 double round hash verification process, the math that verifies each block in the chain. Complete a block, and you are rewarded with a portion of a coin. Essentially, your processing power is converted into coins. The main cost is the electricity burnt to run the hardware. To help take some of the randomness out of hitting the solutions to each block, it's best to join a mining pool, where efforts and rewards are spread.

In the early days, an average PC could do the job—the blockchain was short and the math simpler. Fat chance now; you really need Application-Specific Integrated Circuits, or ASIC machines. These rigs pack the required mathematical power but are otherwise pared down to the minimum. Mining power is measured in hashes per second (the base operation of the cryptography). These days, this is expressed in trillions of hashes per second (TH/s). Probably more important is efficiency: watts per gigahash (W/GH). Powerful machines are not cheap—a 14TH/s box running at 0.1W/GH would set you back $2,750 or so. Older and smaller machines are much cheaper—$200 or so—but are horribly inefficient. Margins are tight, and the field of play very fluid. It's a delicate balance between profit and loss, and only the latest and most efficient hardware has a chance to run profitably.

Still want to mine? If you're serious, you'll need an air-conditioned room, with substantial racks of the latest ASIC machines, and a friendly electricity company. Too much? You can run a box or two at home, or cobble together custom rigs using high-end graphics cards. You don't have to own the hardware yourself; cloud mines rent out capacity. You pay so much per TH/s, and hope it's less than the returns.

New cryptocurrencies are a gamble; modest hardware may return lots of coins, which the market may then decide are near worthless. Accusations of scams abound, and many clones of current blockchains are launched, and many flounder. Yes, you could hit a winner early and win big, but the mining world is pretty savvy now, and competition fierce. Or you could stick to one of the established coins, and find you've turned $500 of electricity into $300 of coins. It happens.

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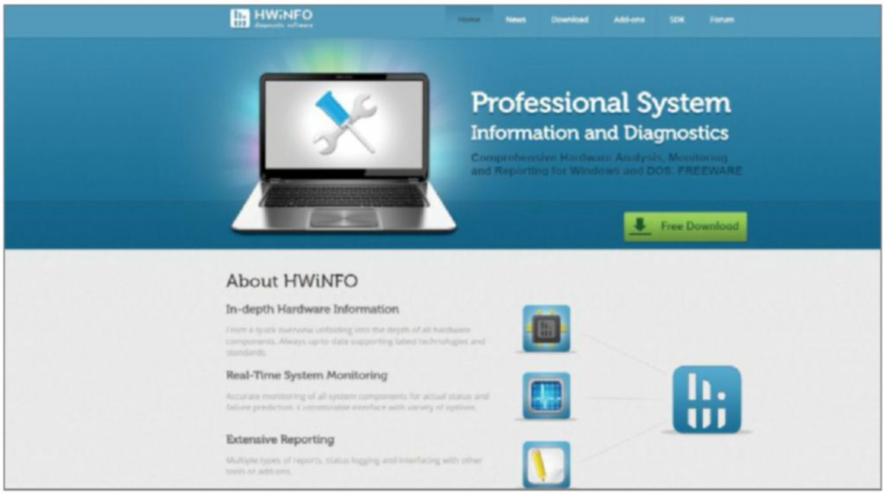
STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

TIP OF THE MONTH



Professional System Information and Diagnostics

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About HWiNFO

In-depth Hardware Information

Real-Time System Monitoring

Extensive Reporting

MEASURING RYZEN TEMPS

Fed up with Ryzen temperatures measuring 20 degrees higher than they actually are? We are. If you head to www.hwinfo.com and download the free hardware analysis tool, you can deduce accurate Ryzen temperatures without worrying about AMD's ridiculous offset. On top of that, once you've installed HWInfo, it seems HWMonitor also accounts for that temperature offset, too. It's just a shame it doesn't work at the BIOS level.

MAKE – USE – CREATE

60
Build your own darknet with Tor and OnionShare

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Create a striking eclipse montage using Photoshop

70
Step-by-step guide to putting together a big Ripper rendering rig

ZAK STOREY
REVIEWS EDITOR

VIDEO ASPIRATIONS

It's been a crazy month, with a lot of ups and downs, reshuffles at the mag, and settling into new positions. I've been itching to get into the video scene for a while, but finding the time to do so has been challenging. My job is intense, and it's rare for me to find time outside of my regular duties. That said, I'm moving to a new position, and now have a little leeway (basically, I'm using my Saturdays) to hopefully produce video content for that old book of faces, and maybe even YouTube. Let's be frank: *Maximum PC* has been around for a while now, and the fact we don't have some form of regular digital content online outside of *PC Gamer's* hardware site is a little disheartening.

This is something I plan to rectify, with help from my executive editor, Alan Dexter. Thing is, we're going to need a fairly beefy machine. The less time spent rendering, the better.

As we received two Threadripper parts with our review sample, and as we have a habit of holding on to our more affordable, mid-range parts for future features, it'd be a shame not to use that 16-core CPU. So, farewell Core i7-5820K workstation, and hello AMD Threadripper. More than doubling the thread count and increasing memory to 128GB of DDR4, with a few other choice components from last year's Dream Machine, we should have the perfect proving ground for those video antics of ours.

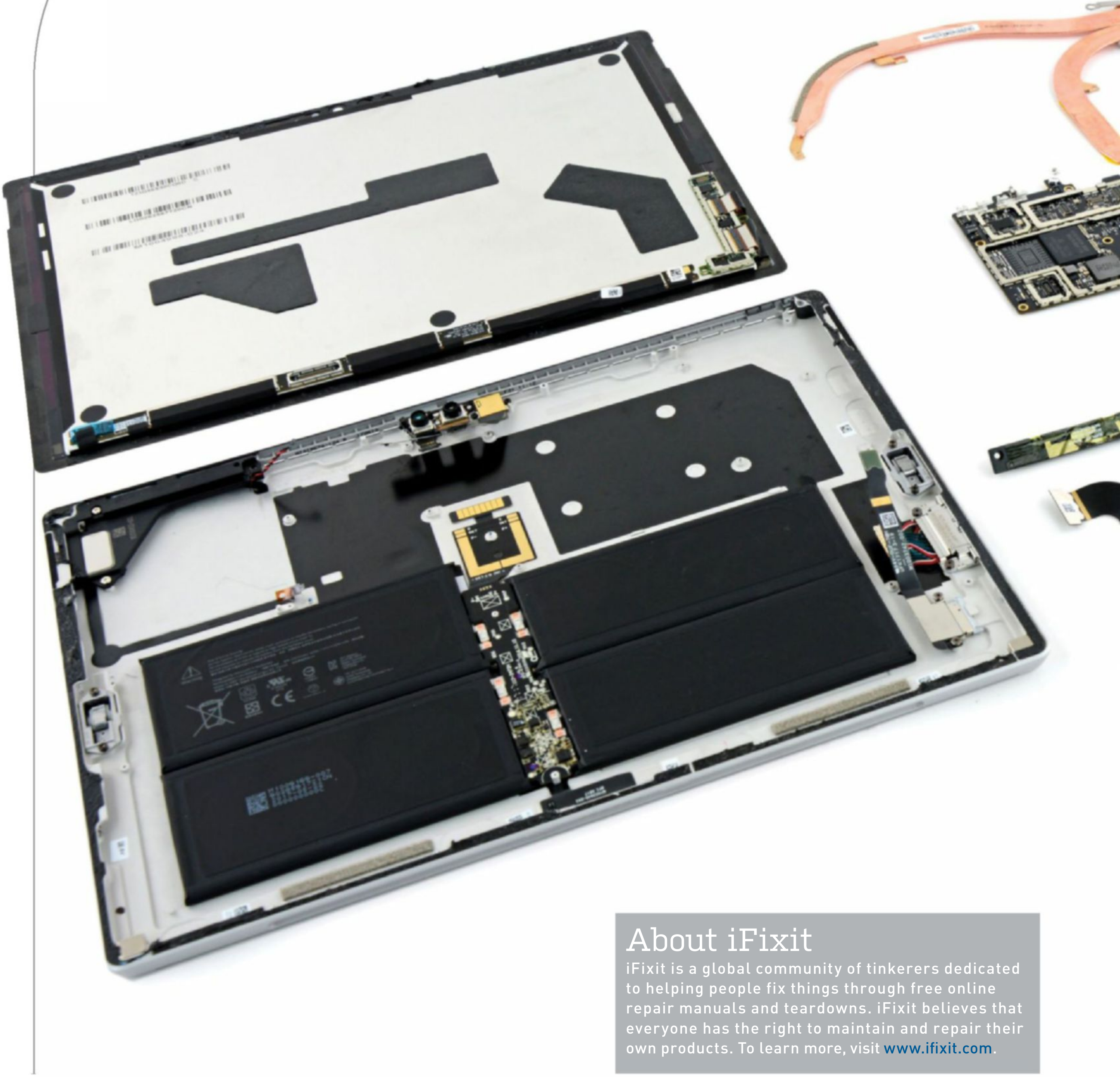
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

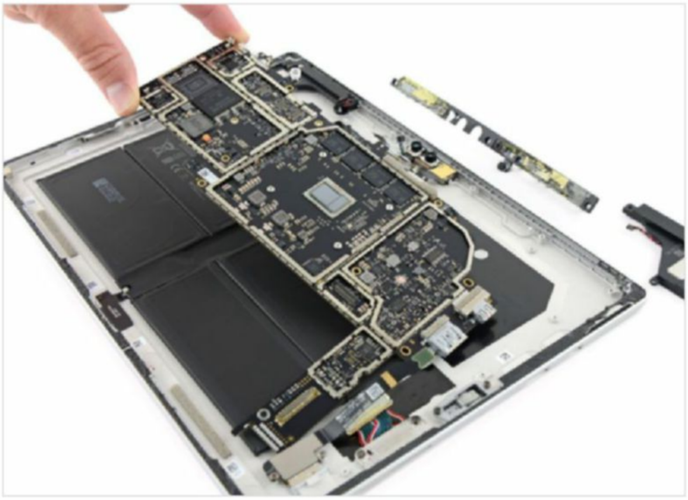
Microsoft Surface Pro 5



About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.

Even the Core i5 doesn't require active cooling.



BACKGROUND

Microsoft's hardware is having an identity crisis. The company calls this new Surface Pro "the most versatile laptop," which means that this apparent tablet is actually a laptop (that can transform into a Studio Surface). Tell ya what, Microsoft, we're going to reach deep inside and see if we can help.

MAJOR TECH SPECS

- 12.3-inch IPS PixelSense display with 2736x1824 resolution (267 ppi)
- Intel Kaby Lake Core m3 (4M Cache, 2.7GHz) up to Core i7 (4M Cache, 4.0GHz) CPU
- 4GB/8GB/16GB 1,600MHz DDR3L RAM
- 128GB/256GB/512GB/1TB of solid-state storage
- 8MP rear-facing 1080p camera, and 5MP front-facing 1080p Windows Hello camera
- USB 3.0 port, microSD slot, Mini DisplayPort, and SurfaceConnect charging port.
- 802.11a/b/g/n/ac Wi-Fi, Bluetooth 4.1

KEY FINDINGS

- We start looking for differences and pick out a whopper: Microsoft has traded away the removable blade SSD for more battery real estate. There goes the sole upgradable feature from last year's model. Less exciting differences include a more spidery heatsink design, four-cell instead of two-cell battery, and svelte new black color scheme. The back of the display houses chips that look suspiciously similar to the N-trig modules found in the Surface Pro 4.
- Microsoft claims to have wholly redesigned the passive cooling, to allow both the Core m3 and Core i5 models to run 100 percent fanless, instead of just the m3 model, like last year. It looks as though most of the improvement came from shaping the heatsink like a certain Zerg unit. With the heatsink out of the way, we still have to remove a couple of components before the motherboard is free. It's trapped under one speaker and a sensor/camera bezel.
- If we learned anything from the last Surface Pro we tore down, it's that the battery is a pain to remove, and it doesn't go back quite the same. So, we're gonna keep it glued in. This four-cell LiPo measures in at 45Wh (7.57V x 5,940mAh). That's nearly an 18 percent increase in battery capacity (and 100 percent increase in cell count) over the previous model. To compare Apples to Apples, sorry, Surfaces, the 10.5-inch iPad Pro sports a 30.8Wh battery.
- All told, it's nearly identical to its predecessor—aside from ditching the last remaining upgradable component, the modular SSD. Yeah, Microsoft impressed us—by being way worse than we expected. We also took a look at the Core i7 Surface Pro, and there's not much difference, but the mysterious empty space under the heatsink is filled with extra cooling power in the form of a fan.
- Repairability Score: 1 out of 10 (10 is easiest to repair). Although we like connectors, the ones here aren't standard, making display removal tricky; the procedure is simplified by the use of thin foam adhesive and a fused display, but is still not trivial. Adhesive holds many components in place, including the display and battery. Replacement of any part requires removal of the display assembly, an easy part to damage. The SSD is no longer replaceable.

Build Your Own Darknet with Tor

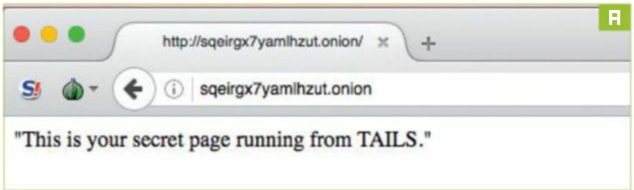
YOU'LL NEED THIS

TOR BROWSER
The Tor Browser Bundle is needed by anyone you want to access your hidden service.

ONIONSHARE
This generates a unique .onion address for your contacts to download your files: https://onionshare.org.

TOR ENABLES YOU TO SET UP a "hidden service" on the darknet. This involves setting up a server using Apache2 software, and generating a .onion address, so that other Tor users can connect. By default, anyone in possession of the address, such as www.facebookcorewwwi.onion, can connect to a Tor hidden service. For big sites, such as Facebook, there's no harm in this, because everyone knows who owns the site, and its business model thrives on people connecting and sharing data.

For private citizens in various parts of the world, who are subject to monitoring of web traffic, the very fact that they've downloaded server software is recorded by their ISP, as is the fact they are using Tor. This means that setting up a Tor hidden service anonymously is tricky. Even once it's up and running, other people connecting to it risk that one of Tor's nodes has been compromised, and will record that .onion address. Malicious web crawlers, such as PunkSPIDER, have even been able to map the entire Tor darknet, checking hidden services for vulnerabilities. This in itself is not a major security concern, because knowing the address of a website is only the first step to hacking into its server, but if you only want to share information with a limited group of people, there is a way to prevent rogue scanners from connecting automatically to your hidden service, and discovering your server's real IP address. Read on.... –**NATE DRAKE**



"This is your secret page running from TAILS."

1 STEALTHY ONIONS

To keep your hidden service hidden, you need to use "stealth" onion services. In brief, the way this works is that you generate a unique .onion address for each individual user of your website [**Image A**], in addition to an authentication "cookie."

» In order to connect to your Tor hidden service, users need both this unique .onion address and the cookie. Any other person or service simply sees a message saying that it failed to connect.

» The steps in the "Set Up Your Darknet Site" walkthrough (pg. 63) cover generating unique authentication cookies and onion addresses for your contacts [**Image B**]. You need to help them configure their Tor Browser Bundle on computer and/or mobile device to store the cookie, so they can access your service. Do this by modifying the "torrc" configuration file inside their Tor software.

2 SUPER TAILS

For this project, we're using TAILS (The Amnesiac Incognito Live System). This OS has been designed with privacy in mind. All connections are routed through the Tor network, so there's less danger of leaking your real IP address.

» TAILS is designed chiefly for Internet users who want to access the darknet by booting from a USB or DVD, and loading into their RAM memory. The advantage of this is that after the machine restarts, there's no trace left of your Internet activity.

» The downside to this, of course, is that there is data you may want to save, such as passwords and email addresses. For this reason, TAILS comes with an optional "persistent" mode when installed on USB stick, to store such data.

» The "Persistent" section is encrypted, and you need to set a password to unlock it each time you boot TAILS. Follow the steps in the "Setting Up TAILS" boxout (pg. 62) to do this. Your website and any associated files are stored safely inside the "Persistent" section. This hugely increases the physical security of your server, because the drive is encrypted, and you can easily remove or destroy it.

3 LIGHTWEIGHT SERVER

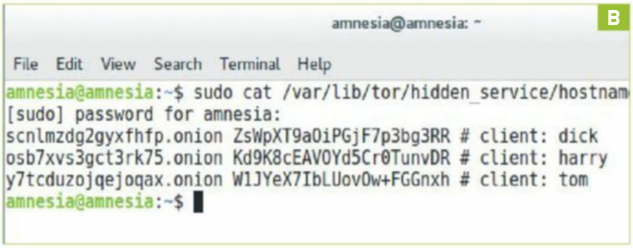
Tor can work seamlessly with a variety of server software. This project focuses on Nginx-light which, as the name suggests, is a bare-bones version of the more full-featured Nginx. The server software works on the basis of HTTP modules, which support basic websites, but not more advanced features, such as mail. This tutorial works just as well with the full version of Nginx, although increasing your attack surface could make your server more vulnerable.

» If you want to have extra features for your server, such as email, simply substitute "nginx-light" with "nginx-full" in the scripts.

4 GETTING STARTED

TAILS is not designed primarily to work as a server, although there are plans to introduce this ability as a feature in the future. However, because it's based on Debian Linux, you can install all the programs you need to turn it into one.

» The Debian Project is also good enough to host a mirror of its servers on the darknet. Given certain governments' decision to monitor all Internet traffic, this is a great relief for some people, because as you'll be installing via Tor



```
amnesia@amnesia:~$ sudo cat /var/lib/tor/hidden_service/hostnam
[sudo] password for amnesia:
scnlmzdg2gyxfhfp.onion ZsWpXT9aOiPGjF7p3bg3RR # client: dick
osb7xvs3gct3rk75.onion Kd9K8cEAVOYd5Cr0TunvDR # client: harry
y7tcduzojqejoqax.onion W1JYeX7IbLUovOw+FGGnxh # client: tom
amnesia@amnesia:~$ █
```

BACKUP SCRIPTS

To run a server on TAILS, you need to save your software, web pages, and client keys so they can be restored if necessary. These are saved in the encrypted "Persistent" section of the USB stick (see box over page).

Open Terminal in TAILS, then create a folder to store backups with `mkdir /home/amnesia/Persistent/tails-server`. Next, run `sudo nano /home/Amnesia/Persistent/backup.sh` and paste in:

```
cp /etc/nginx/sites-available/default /home/ amnesia/Persistent/tails-server/
cp /etc/nginx/nginx.conf /home/amnesia/ Persistent/tails-server/
cp /etc/tor/torrc /home/amnesia/Persistent/tails- server/
cp /var/lib/tor/hidden_service/hostname /home/ amnesia/Persistent/tails-server/
cp /var/lib/tor/hidden_service/private_key /home/amnesia/Persistent/tails-server/
cp /var/lib/tor/hidden_service/client_keys /home/amnesia/Persistent/tails-server/
chmod -R 0777 /home/amnesia/Persistent/ tails-server/
echo Done.
```

Save and exit. Make it executable:

```
sudo chmod a+x /home/amnesia/Persistent/ backup.sh
```

Run the backup:

```
cd /home/amnesia/Persistent
sudo ./backup.sh
```

Now press Ctrl-X, Y, then Enter to save and exit.

Make the script executable with `sudo chmod a+x /home/amnesia/Persistent/backup.sh`.

Use `cd /home/amnesia/Persistent` to switch to the "Persistent" directory, then run a backup with `sudo ./backup.sh`.

To create the restore script, run the command `sudo nano /home/amnesia/Persistent/restore.sh`, and then paste in the following:

```
apt-get update
apt-get install -y nginx-light ufw
ufw enable
cp /home/amnesia/Persistent/tails-server/torrc / etc/tor/torrc
service tor restart
service tor stop
service nginx stop
cp /home/amnesia/Persistent/tails-server/ default /etc/nginx/sites-available/
cp -f /home/amnesia/Persistent/tails-server/ hostname /var/lib/tor/hidden_service/
cp -f /home/amnesia/Persistent/tails-server/ private_key /var/lib/tor/hidden_service/
cp -f /home/amnesia/Persistent/tails-server/ client_keys /var/lib/tor/hidden_service/
cp /home/amnesia/Persistent/tails-server/nginx. conf /etc/nginx/nginx.conf
chown -Rv www-data:www-data /var/www/
service tor start
service nginx start
echo Restored.
```

Save and exit. Make the script executable with `sudo chmod a+x /home/amnesia/Persistent/restore.sh`. To test, restart TAILS, and run the restore script. Use `cd /home/amnesia/Persistent` to switch to the "Persistent" directory, then restore the server with `sudo ./restore.sh`.

hidden services, it's virtually impossible for anyone to tell you're downloading server software in the first place.

›› Follow the steps in the boxout over the page to make sure TAILS connects to the darknet using "bridges." This makes it harder for your ISP to detect you're running a hidden service.

›› At this point in time, TAILS cannot be run headlessly—that is, without a monitor, keyboard, and mouse—so be sure to choose a machine you won't need while your hidden service is running. This also means that you need to be present each time TAILS boots up, to enter passwords and restore your data.

›› The TAILS website says that at least a 4GB USB stick is required to run the OS. Play it safe, and choose at least an 8GB one, because hopefully your website will grow over time.

›› Before following the step-by-step guide (pg. 63), note down the people who will be accessing your service, and ask each of them either to install the Tor Browser Bundle on their machines and/or Orbot on their Android device. You can always remove or add more users later on if you wish.

5 SET UP YOUR WEBSITE

The "Set Up Your Darknet Site" walkthrough outlines how to create a basic index page to let you know the server is working correctly—however, after going to all this trouble, you will probably want more than this.

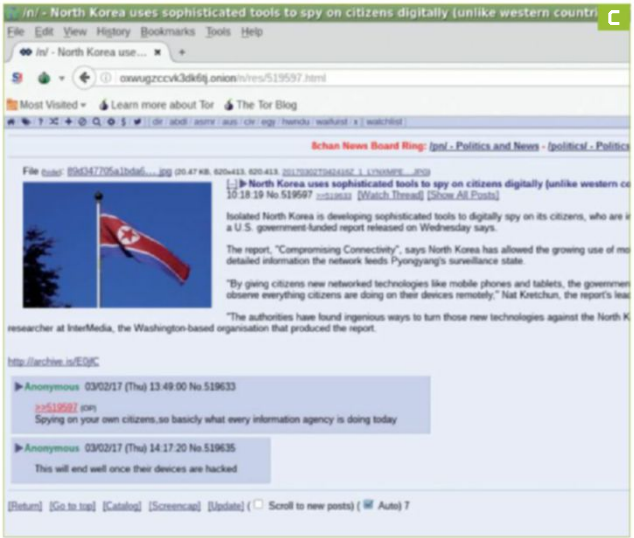
›› Tor hidden services can host most kinds of websites, though given that you're running yours from a USB stick, the more lightweight the better. If, for instance, you want to run an imageboard, consider using vichan [**Image C**], which is a fork of the now defunct tinyboard. Refer to each program's project page to see whether any additional software is required, such as MySQL. If so, be sure to modify your "restore" script (see above) to make sure this can be automatically installed each time you restart TAILS.

6 LOCK DOWN YOUR SERVER

Once your hidden service is up and running, consider installing a basic firewall by opening Terminal and running `sudo apt-get install ufw`. Once the install is complete, run the command `sudo ufw enable` to start the firewall. By default, all incoming connections are blocked, and all outgoing connections are allowed.

›› To enable incoming connections on a certain port, use `sudo ufw allow` —for example, `sudo ufw allow 23`.

›› Once all your clients are able to connect to your website, you should take some time to lock down Nginx



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File Edit View History Bookmarks Tools Help
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oxwugzccvk3dk6tj.onion/n/res/519597.html
Most Visited
Learn more about Tor
The Tor Blog
8chan News Board Ring: /pn/ - Politics and News - /politics/ - Politics

[–] ▶ North Korea uses sophisticated tools to spy on citizens digitally (unlike western co
10:18:19 No.519597 [Watch Thread] [Show All Posts]

Isolated North Korea is developing sophisticated tools to digitally spy on its citizens, who are i
a U.S. government-funded report released on Wednesday says.

The report, "Compromising Connectivity", says North Korea has allowed the growing use of mo
detailed information the network feeds Pyongyang's surveillance state.

"By giving citizens new networked technologies like mobile phones and tablets, the governmen
observe everything citizens are doing on their devices remotely," Nat Kretchun, the report's lea

"The authorities have found ingenious ways to turn those new technologies against the North K
researcher at InterMedia, the Washington-based organisation that produced the report.

http://archive.is/E0jiC

▶ Anonymous 03/02/17 (Thu) 13:49:00 No.519633

>>519597 (OP)
Spying on your own citizens,so basicly what every information agency is doing today

▶ Anonymous 03/02/17 (Thu) 14:17:20 No.519635

This will end well once their devices are hacked

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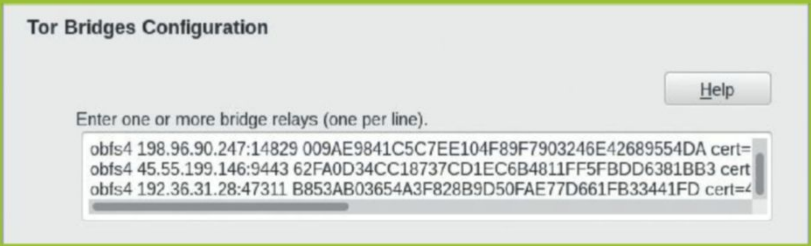
SETTING UP TAILS



Enter one or more bridge relays (one per line).

```
obfs4 198.96.90.247:14829 009AE9841C5C7EE104F89F7903246E42689554DA cert=
obfs4 45.55.199.146:9443 62FA0D34CC18737CD1EC6B4811FF5FBDD6381BB3 cert
obfs4 192.36.31.28:47311 B853AB03654A3F828B9D50FAE77D661FB33441FD cert=4
```

This project is designed to boot from the OS TAILS, installed on USB. Follow the steps outlined on the TAILS website at https://tails.boum.org/install/index.en.html to do this. The USB stick must be at least 4GB in size.

Once installed, restart your machine and boot from USB. You may need to change your BIOS settings to do this. Click "Yes" on "More Options," and type an admin password.

By default, anyone monitoring outgoing connections made by TAILS can see you're using Tor. You can make Tor traffic much harder to detect by visiting https://bridges.torproject.org/options and choosing "obfs4" under "Advanced Options" to get some bridge addresses. Inside TAILS, click "This Computer's Connection is Censored," then "Configure → Yes → Next." Paste in the bridge addresses.

In TAILS, by default all data is lost when you restart your machine. You can create an encrypted volume, however, to store files and settings. Once the desktop loads, click "Applications → Tails → Configure Persistent Volume." Choose a strong passphrase, and click "Create." The wizard asks you which data to save—select "Apt Packages," "Apt Lists" and "Dotfiles," then click "Save."

Restart TAILS to enable persistence fully. On the boot screen, click "Yes" on "Use Persistence?" and enter your new password. Click "Yes" again for more options, and "Forward" to choose an admin password like before. Follow the steps in the "Backup Scripts" section to save and restore your server settings.

properly by running the following command:
`sudo nano /etc/nginx/nginx.conf`

» Remove the `#` at the start of the line starting with the words `server_tokens of`. This means that if an unauthorized person tries to connect, the fact that you're using Nginx-light won't automatically display. Next, scroll down to the "Basic Settings" section, and find "Logging Settings." Put a `#` before the lines starting `access` and `error`.

» This feature disables most logging features, which makes it more difficult for anyone to identify who is connecting to the server, although any error messages are still logged.

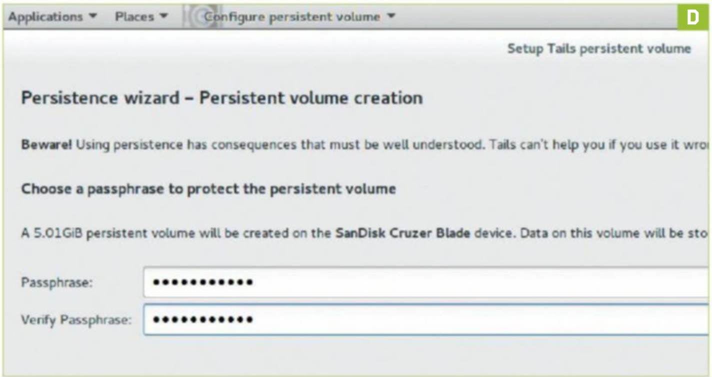
» Now restart Nginx to apply your changes with `sudo service nginx restart`.

» The "light" version of Nginx you're using contains a bare minimum of HTTP modules to set up a basic website, although you can add others if you wish. Bear in mind that the more modules you install, the more likely it is an attacker can find one to exploit.

7 TAILS OF WOE

By its very nature, TAILS is amnesiac. If you remove the USB stick from your computer, or restart the machine itself, all files and settings are lost.

» For this reason, make sure you have enabled persistence [Image D] by following the steps in "Setting Up TAILS" (see the box above) before going through the walkthrough opposite.



Persistence wizard – Persistent volume creation

Beware! Using persistence has consequences that must be well understood. Tails can't help you if you use it wro

Choose a passphrase to protect the persistent volume

A 5.01GiB persistent volume will be created on the **SanDisk Cruzer Blade** device. Data on this volume will be sto

Passphrase: ●●●●●●●●●●●●

Verify Passphrase: ●●●●●●●●●●●●

» Once you're happy that your darknet site is up and running OK, be sure to go through the "Backup Scripts" boxout (see previous page), so that you can save and reload your settings.

» The Riseup website (https://riseup.net/en/security/network-security/tor/onionservices-best-practices) contains some excellent advice for best practices with Tor hidden services. Pay close attention to the section on local host bypasses. And make sure you keep your software up to date, because new vulnerabilities are discovered with TAILS and Tor hidden services all the time.

» That said, remember that Tor supports a number of hidden services, so don't be afraid to experiment with running a private mail server or chat service, as opposed to a simple web page. A good security approach is to think of the authentication token as being only one layer of protection, and you can require users to log in with a separate password to your site.

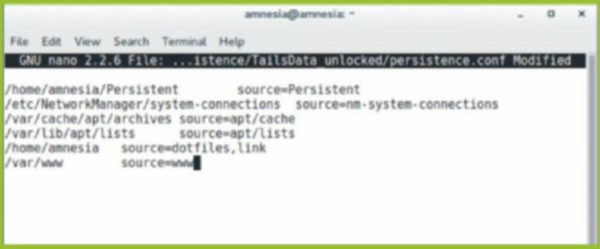
» Also, remember that if anyone can access your machine while TAILS is running, they may also be able to access your client tokens.

» The only safe way to make sure that just people you approve can access your hidden service is if you give them their keys in person. Remember that anyone with access to their device can either use the hidden service or make a copy of the authentication token. Ask them to store their Tor Browser on an encrypted drive. Mobile device users should also enable encryption on their Android device, in case of theft or seizure.

» If you are worried your keys have been compromised, run the command `sudo shred -v /var/lib/tor/hidden_service/client_keys` and restart Tor with `sudo service tor restart`. The system generates new keys for your users.

» Finally, bear in mind that while malicious scanners won't be able to automatically connect to your hidden service, they won't receive the same message they would for an invalid onion address—in other words, they will know the address exists, but it will appear as though the server is down. This isn't exactly plausible denial, but the Tor Project is working on it.

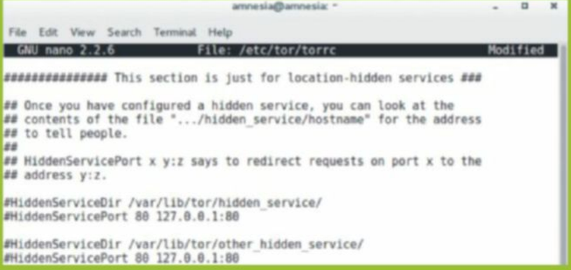
SET UP YOUR DARKNET SITE



```
amnesia@amnesia: ~
File  Edit  View  Search  Terminal  Help
  GNU nano 2.2.6 File: ...istence/TailsData_unlocked/persistence.conf Modified

/home/amnesia/Persistent        source=Persistent
/etc/NetworkManager/system-connections  source=nm-system-connections
/var/cache/apt/archives source=apt/cache
/var/lib/apt/lists      source=apt/lists
/home/amnesia   source=dotfiles,link
/var/www        source=www
```

1. CONFIGURE THE SERVER FOLDER

Follow "Setting Up TAILS" to boot from a USB stick, and set up persistence. Open "Applications → Terminal," run `sudo mkdir /var/www`, then `sudo mkdir /live/persistence/TailsData_unlocked/www`. Edit the persistence config file with `sudo nano /live/persistence/TailsData_unlocked/persistence.conf/`, and add the line `/var/www    source=www` at the end. Press Ctrl-X, then Y, then Enter to save and exit. Reboot TAILS, open Terminal, and run `sudo apt-get update`, then `sudo apt-get install nginx-light`. Run `sudo nano /etc/nginx/sites-available/default`, paste the text in Step 2 at the end, save and exit.



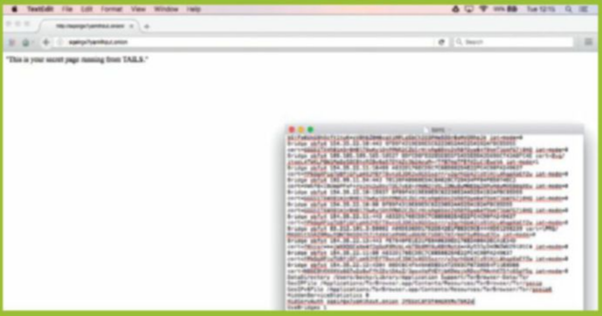
```
amnesia@amnesia: ~
File  Edit  View  Search  Terminal  Help
  GNU nano 2.2.6            File: /etc/tor/torrc                     Modified

############### This section is just for location-hidden services ###

## Once you have configured a hidden service, you can look at the
## contents of the file ".../hidden_service/hostname" for the address
## to tell people.
##
## HiddenServicePort x y:z says to redirect requests on port x to the
## address y:z.

#HiddenServiceDir /var/lib/tor/hidden_service/
#HiddenServicePort 80 127.0.0.1:80

#HiddenServiceDir /var/lib/tor/other_hidden_service/
#HiddenServicePort 80 127.0.0.1:80
```

3. SET UP STEALTH SERVICES

Run `sudo nano /etc/tor/torrc`. Scroll down to "this section is just for location-hidden services." This is where you'll set up a hidden service for each user. Modify the names in the last line before pasting:

```
HiddenServiceDir /var/lib/tor/hidden_service/
HiddenServicePort 80 127.0.0.1:8080
HiddenServiceAuthorizeClient stealth tom,dick,harry
```

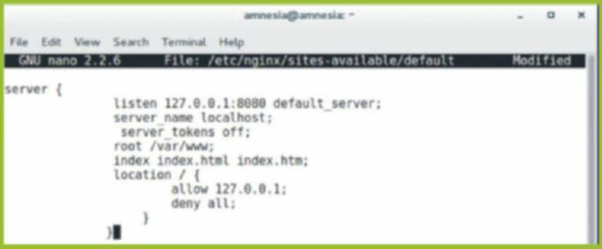
Save and exit.



"This is your secret page running from TAILS."

5. SET UP CLIENT ACCESS (TOR BROWSER)

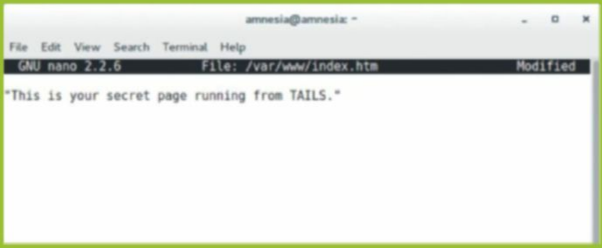
Run `sudo cat /var/lib/tor/hidden_service/hostname` to list access tokens for all users. Ask your user to open their Tor Browser Bundle folder and use a text editor to open the "torrc" file. This is found in "~/[path_to_tor_browser]/Browser/TorBrowser/Data/Tor/torrc" on Linux. Type `HidServAuth`, then paste the line for their Hidden Service Authentication address and cookie at the end.



```
amnesia@amnesia: ~
File  Edit  View  Search  Terminal  Help
  GNU nano 2.2.6       File: /etc/nginx/sites-available/default       Modified

server {
               listen 127.0.0.1:8080 default_server;
               server_name localhost;
                server_tokens off;
               root /var/www;
               index index.html index.htm;
               location / {
                       allow 127.0.0.1;
                       deny all;
                   }
              }
```

2. SET UP A WEB SERVER

```
    server {
          listen 127.0.0.1:8080 default_server;
          server_name localhost;
          server_tokens off;
          root /var/www;
          index index.html index.htm;
          location / {
                allow 127.0.0.1;
                deny all;
             }
          }
```

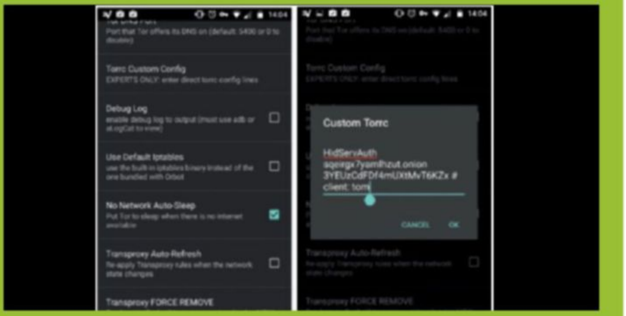


```
amnesia@amnesia: ~
File  Edit  View  Search  Terminal  Help
  GNU nano 2.2.6           File: /var/www/index.htm                   Modified

"This is your secret page running from TAILS."
```

4. CREATE AN INDEX PAGE WITH PERMISSIONS

Create a simple landing page for your website with `sudo nano /var/www/index.htm`. Type in some text, such as "This is your secret page running from TAILS," then save, and exit. Give the www user ownership of the "/var/www" folder with `sudo chown -Rv www-data:www-data /var/www`. Restart Tor and Nginx with:

```
sudo service tor restart
sudo service nginx restart
```



HidServAuth
sqeirgx7yamlhzut.onion
3YEUzCdFDf4mUXtMvT6KZx #
client: tom

6. SET UP CLIENT ACCESS (ORBOT)

If your contacts prefer to use mobile devices, ask them to install the apps Orbot and Orweb on their Android device. Next, start Orbot and go to "Menu → Settings → Torrc Custom Config." Type the word `HidServAuth`, then leave a space, and paste in their entry from hostname. They can now access your hidden service using the Orfox browser.

Go Headless with Your Raspberry Pi

YOU'LL NEED THIS

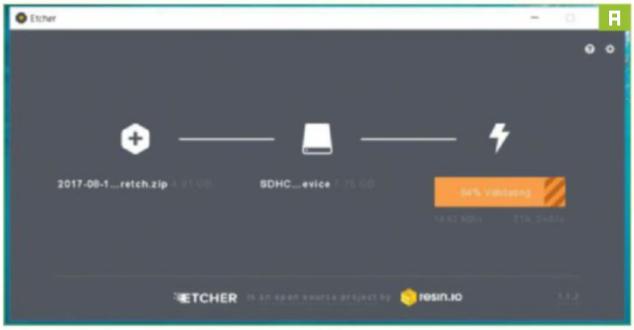
RASPBERRY PI
Whichever model you have to hand will work.

SD CARD
Or MicroSD for later models.

ETHERNET CABLE
For a stable connection.

WE'VE TALKED MANY TIMES about the Raspberry Pi, and in just about every one of our Pi explorations we've mentioned the possibility of running it headlessly. This means, as the word "headless" obliquely suggests, cutting off the machine's face, and disabling most of its senses—disconnecting the monitor, keyboard, and mouse, and running the Pi entirely as a network-attached device. This isn't as mad as it may sound. The Pi can play many roles, from NAS to network administration to web hosting and beyond, that have no need for any attached peripherals. And, let's face it, while the Raspbian desktop is functional, running graphical apps does not play to the Pi's strengths.

So, let's break down what you need to do to make any Pi capable of running headlessly, and the methods you then need to use to connect to and administer that box through a Windows machine. For the full effect, you need to start with peripherals attached to your Pi, but they won't be hooked up for long; if you don't have spares, borrow your regular USB mouse and keyboard. **–ALEX COX**

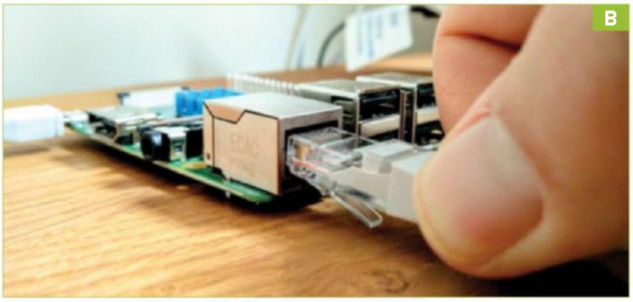

A
Etcher
2017-08-1...retch.zip
SDHC...evice
84% Validating
ETCHER
resin.io

1 INSTALL RASPBIAN

If you already have an existing Raspbian installation working with your Raspberry Pi, you can skip this step, and if you're already using something different—such as Arch or RiscOS—your methodology is going to be slightly different, though the principle remains the same. Grab a clean Raspbian Stretch disk image from www.raspberrypi.org/downloads/raspbian, then download Etcher from https://etcher.io. The latter is a new disk image writer on the scene, but it's about as foolproof as these things get. Once you have it up and running, click "Select image," and pick your Raspbian file, click "Select drive," and pick your SD drive, then click "Flash" to unite the two [**Image A**].

2 HEADS UP

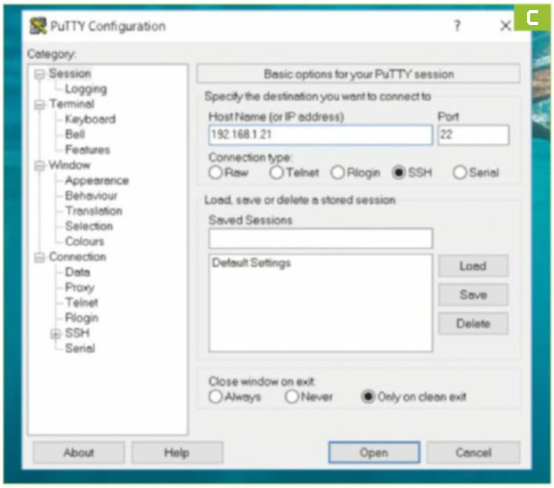
With everything safely installed, hook up your Pi to your peripherals and monitor, then to your router, using an Ethernet cable if possible [**Image B**]. Power it up. A new Raspbian install automatically runs a console application called raspi-config; if you have an existing install, just drop to the text terminal (from the desktop, hit Ctrl-Alt-F1), and run `raspi-config` to get there manually. Head to "Interface options/SSH," and switch on SSH, which stands for Secure Socket Shell. This is the protocol we'll use to communicate with the Pi's terminal over the network. Exit raspi-config, and (still in the console) run `ifconfig eth0` to get the IP address of the Raspberry Pi.



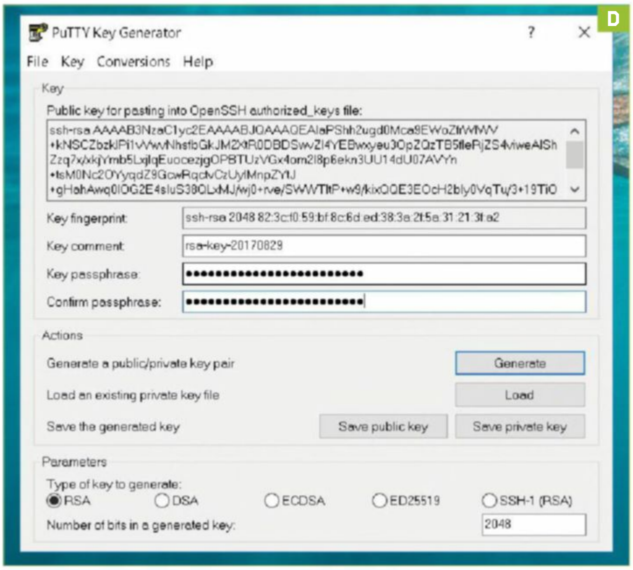
3 MAKE IT STATIC

If your Pi or your router get rebooted, the IP address you just discovered might change—that's not ideal, considering that we're looking to access it via the network. So, let's lock it down. Type `sudo nano /etc/dhcpcd.conf` to tweak the appropriate Raspbian config file (the default su password is "raspberry" when you're asked), and head to the bottom of the file. Add the following, replacing the static address with that of your Pi (leaving the "/24" part at the end), and the others with that of your router:

```
interface eth0

static ip_address=192.168.0.100/24
static routers=192.168.0.1
static domain_name_servers=192.168.0.1
```


C
PuTTY Configuration
Category:
Session
Logging
Terminal
Keyboard
Bell
Features
Window
Appearance
Behaviour
Translation
Selection
Colours
Connection
Data
Proxy
Telnet
Rlogin
SSH
Serial
Basic options for your PuTTY session
Load, save or delete a stored session
Saved Sessions
Default Settings
Load
Save
Delete
About
Help
Open
Cancel

Specify the destination you want to connect to
Host Name (or IP address): 192.168.1.21
Port: 22
Connection type: ○ Raw ○ Telnet ○ Rlogin ● SSH ○ Serial
Close window on exit: ○ Always ○ Never ● Only on clean exit


D
PuTTY Key Generator
?
✕
File
Key
Conversions
Help
Key
Actions
Generate
Load
Save public key
Save private key
Parameters

Public key for pasting into OpenSSH authorized_keys file:

```
ssh-rsa AAAAB3NzaC1yc2EAAAABJQAAAQEAlaPShh2ugd0Mca9EWoZlrWMV
+kNSCZbzkJPi1VWwNhsfbGkJM2XR0DBDSwZl4YEBwxyeu3OpZQzTB5fleRjZS4viweAlSh
Zzq7x/xkjYmb5LxjlqEuocezjgOPBTUzVGx4om2l8p6ekn3UU14dU07AVYn
+IsM0Nc2OYyqdZ9GcwRqdvCzUylMnpZY1J
+gHahAwq0lOG2E4sluS38OLxMJ/wj0+rve/SWWTltP+w9/kixQOE3EOcH2bly0VqTu/3+19TiO
```

Key fingerprint: ssh-rsa 2048 82:3c:f0:59:bf:8c:6d:ed:38:3a:2f:5e:31:21:3f:a2

Key comment: rsa-key-20170829

Key passphrase: ••••••••••••••••••••••••••

Confirm passphrase: ••••••••••••••••••••••••••

Generate a public/private key pair

Load an existing private key file

Save the generated key

Type of key to generate:
● RSA ○ DSA ○ ECDSA ○ ED25519 ○ SSH-1 (RSA)

Number of bits in a generated key: 2048

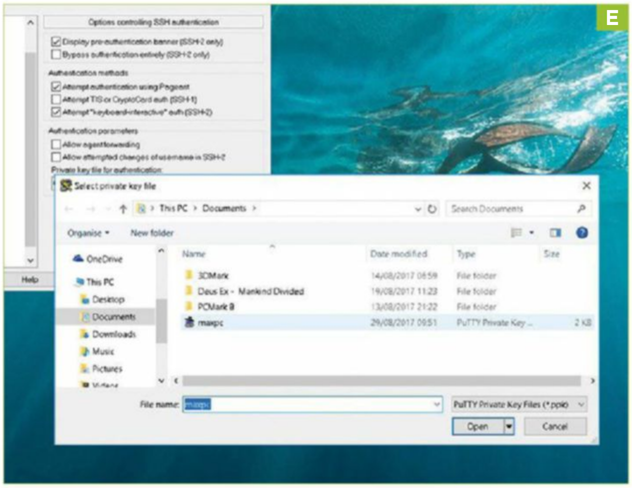
›› If you're connecting with Wi-Fi, rather than good old RJ45, you can safely replace "eth0" with "wlan0"—or even, if you like, apply a static address to both networks by duplicating the same chunk of text. When you're finished, exit Nano with Ctrl-X, and hit Y when prompted to save the changes to the file.

4 A QUICK TEST

Type `sudo reboot` to reinitialize Raspbian with these new settings, and check that they've sunk in by once again running `ifconfig eth0`, and ensuring that the IP address is as you'd expect. Run `sudo service ssh status` to check that your SSH server is up and running, and you should be good to go. Now jump on your Windows machine, head to www.putty.org, and download the relevant PuTTY installer for your system. Install it with the default options, and run PuTTY. Add your Pi's local IP address in the "Host Name" box at the top of the window [**Image C**], and click "Open." You should connect directly to your Pi's command line terminal. If so, feel free to disconnect your peripherals and reboot—you're now running headless.

5 KEY CUTTING

The first "S" in SSH stands for "secure," but your current connection—to an open Raspberry Pi with the default password—is far from it. The first course of action is, naturally, to change that default Pi password by running `passwd pi` in the terminal. Now, on your Windows machine, run PuTTYgen [**Image D**] to begin the process of creating a secure key pair. Leave the options at the defaults, click "Generate," and wiggle your mouse over the blank area. Type a long passphrase to protect your private key—this will be the password you use to log in, going forward—then click "Save private key" to generate a secure .ppk file, and "Save public key" to create a plain text file containing the public key. Put these somewhere safe.


E
Options controlling SSH authentication
Authentication methods
Authentication parameters
Help
Select private key file
✕
This PC › Documents ›
Search Documents
Organise ▾
New folder
OneDrive
This PC
Desktop
Documents
Downloads
Music
Pictures
Videos
Open
Cancel

☑ Display pre-authentication banner (SSH-2 only)
☐ Bypass authentication entirely (SSH-2 only)

☑ Attempt authentication using Pageant
☐ Attempt TIS or CryptoCard auth (SSH-1)
☑ Attempt "keyboard-interactive" auth (SSH-2)

☐ Allow agent forwarding
☐ Allow attempted changes of username in SSH-2
Private key file for authentication:

Name	Date modified	Type	Size
3DMark	14/08/2017 08:59	File folder	
Deus Ex - Mankind Divided	19/08/2017 11:23	File folder	
PCMark 8	13/08/2017 21:22	File folder	
maxpc	29/08/2017 09:51	PuTTY Private Key ...	2 KB

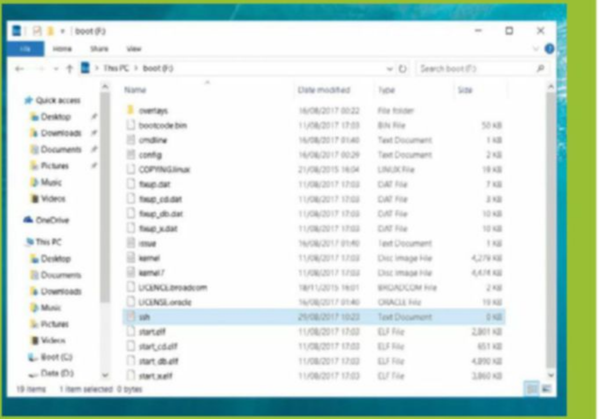
File name: maxpc

PuTTY Private Key Files (*.ppk)

6 LOCK IT DOWN

Open PuTTY, log in to your Pi as normal, and type `mkdir ~/.ssh` to create a directory to house the public portion of the key, then `chmod -R og= ~/.ssh` to ensure that only you are allowed to write to and read from that directory. Run `sudo nano ~/authorized_keys`, then copy and paste the public key from the top of the PuTTYgen window into this file. Save it, and end your PuTTY session for now. Back in the main PuTTY interface, drill down in the left column to "SSH → Auth," and use the "Browse" button to point it at your .ppk private key [**Image E**]. Log in to your Pi again, and you should be asked for the password of the private key—if all has gone well, you can now use Nano to edit the "/etc/ssh/sshd_config" file, and set password authentication to "no." Reboot, and the only way you'll be allowed in is by using your private key. ⏻

GO TRULY HEADLESS


boot (F:)
File
Home
Share
View
This PC › boot (F:)
Search boot (F:)
Name
Date modified
Type
Size
Quick access
Desktop
Downloads
Documents
Pictures
Music
Videos
OneDrive
This PC
Desktop
Documents
Downloads
Music
Pictures
Videos
Boot (C:)
Data (D:)
overlays
bootcode.bin
cmdline
config
COPYING.linux
fixup.dat
fixup_cd.dat
fixup_db.dat
fixup_x.dat
issue
kernel
kernel7
LICENCE.broadcom
LICENSE.oracle
ssh
start.elf
start_cd.elf
start_db.elf
start_x.elf
19 items
1 item selected 0 bytes

Can you really not spare a keyboard and monitor for a few minutes? No problem. As long as you're OK with using Raspbian as your Pi's OS, and you're using a Raspberry Pi with an Ethernet port, there's a quick workaround to enable SSH—and therefore headless operation—before you've even booted the Pi once.

Write your SD card with the OS as usual, then open up the card in Windows' file explorer. Right-click in the white space of the drive, and head to "New → Text Document." Name this blank text file "ssh" with no file extension, then remove the SD card, insert it into your Pi, attach an Ethernet cable to connect it to the network, and power it up.

Open a web browser on your main PC, and connect to your router's interface. Head to its DHCP allocation table, and work out which IP address the Pi has been assigned; you can now connect to this address via PuTTY, and get on with the rest of that critical headless configuration.

Stabilize Your Wobbly Video Files

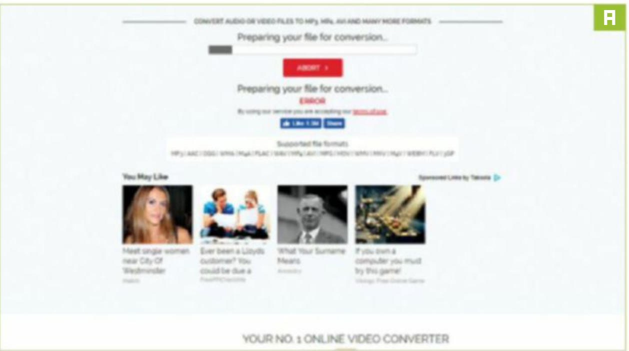
YOU'LL NEED THIS

VIRTUALDUB
Free, deceptively powerful, open-source video-editing software. Download it from www.virtualdub.org.

DESHAKER PLUGIN
Stabilizes videos within VirtualDub. Also free. Grab it from www.guthspot.se/video/deshaker.htm.

NOT ALL VIDEOS ARE CREATED EQUALLY. You only have to sit through *Suicide Squad* to figure that much out, but we're not taking dire scripting to task now. Instead, we're focusing on stabilizing shaky video files. We don't carry tripods everywhere we go, and last time we looked around, nor does anyone else. As a result, much of the smartphone and GoPro video we create contains juddering images due to our shaky hands or uneven terrain, and that can be fairly unpleasant to watch for more than a few seconds, daughter's first steps or not. Camera hardware itself can help with this problem to an extent, but good stabilization lenses are expensive, and not applicable to GoPro recording. So, instead, we're turning to our trusty PCs, loading some absolutely cost-free software up, and taking the shakiness out ourselves.

It's worth noting at this point that it's more than possible to go too far when using any stabilization plugin or software, leaving the stabilized video looking worse. Like much of video editing, it requires something of a deft touch. If you don't possess such a thing, a long evening of trial and error, and a handy magazine guide will get you there, too. –PHIL IWANIUK

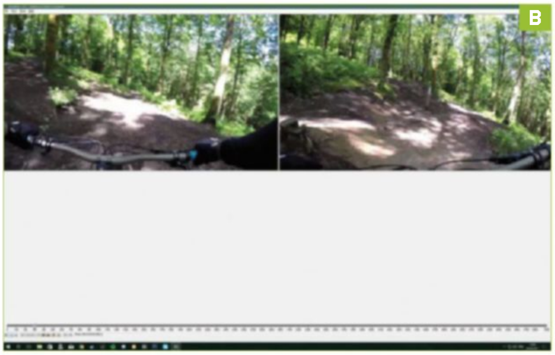

A
CONVERT AUDIO OR VIDEO FILES TO MP3, MP4, AVI AND MANY MORE FORMATS
Preparing your file for conversion...
ABORT
Preparing your file for conversion...
ERROR
Supported file formats
You May Like
What Your Surname Means
YOUR NO. 1 ONLINE VIDEO CONVERTER

1 CONVERT YOUR VIDEO FILE TO AVI

We're using VirtualDub to achieve our goal, because although Premiere Pro is fantastic (see boxout opposite), it's also quite expensive and definitely overkill for a task like this. VirtualDub has been around since 2004, and although it's compatible with 64-bit systems and Windows 10, it can be a little fussy in some respects. One of them is the video file types it reads: AVI is the safest bet, so if you have an MP4, a WMV, or (god help you) an MKV sitting on your desktop, ready for attention, you need to run it though a converter first. Browser-based converters such as Online Video Converter (www.onlinevideoconverter.com/cloud-converter) will do the trick nicely [**Image A**]. Just ignore the advertisements asking you to "Come play, my lord...."

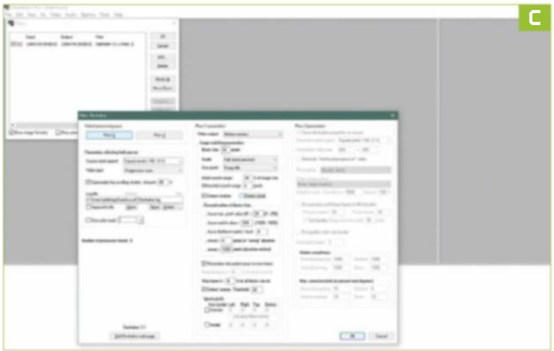
2 OPEN IT IN VIRTUALDUB

Now you have a freshly baked AVI waiting to be stabilized, open up VirtualDub, and either drag the video file anywhere within the window, or to go "File," and "Open Video File" [**Image B**]. If your video has a variable bit rate (VBR), you get a warning message at this point, but it's nothing to worry about. If you don't have a codec pack installed on your PC, you may also get an error message telling you VirtualDub can't load the file. That's nothing to lose sleep over either—just download the codec you need, install it to the default directory, and you're set. Yet another possibility at this stage is that you get an error message about loading audio when you try to play the file. There are several solutions to this, but the easiest is to disable audio and pair it up later in a separate program.



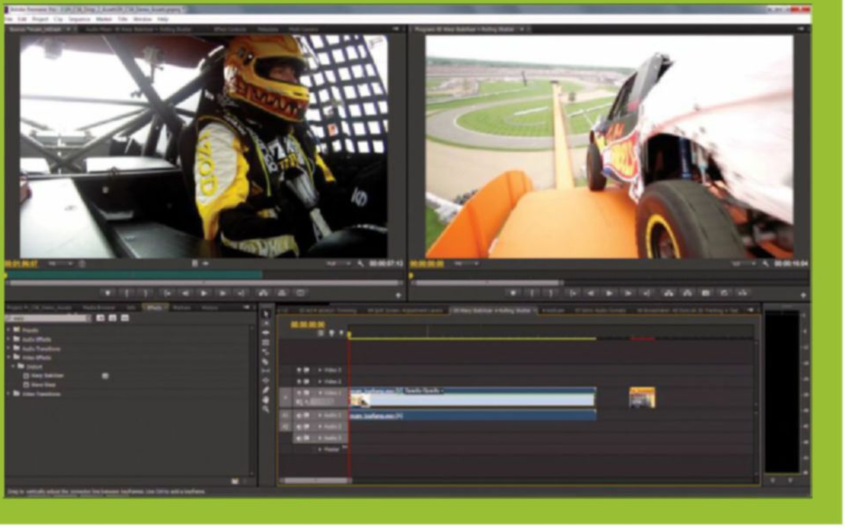
3 APPLY THE DESHAKER 3.1 FILTER

Deshaker is a powerful stabilization tool, which uses tracking pixels to make sense of the direction of movement in a video file, and even enables you to guide it manually if you're feeling brave. For this guide, we're letting the plugin itself do the legwork. Download Deshaker 3.1 from www.guthspot.se/video/deshaker.htm, making sure to download the 64-bit version if you're running a 64-bit OS installation, and 32-bit if you're not. Place the file in the "Plugins" directory within your VirtualDub install folder. Now, in VirtualDub itself, with the video you want to stabilize loaded, click "Video" on the top bar, and then "Filters," then "Add" in the window that appears. Find



PREMIUM PERMANENCE

To no one's surprise, Premiere Pro can handle this type of task very effectively and in a slightly more user-friendly manner. Warp Stabilizer launched within After Effects in CS5.5, but as of CS6, it's built into Premiere Pro itself. Applying it is as simple as locating it in your effects panel and dragging it on to a clip—usually the default values are more than enough to give you the desired effect, but you can adjust the smoothness if it looks too jarring. It takes a moment for the software to analyze your footage, and then… well, that's it. Done. Please return to your homes. There's no denying it's an easier way than using VirtualDub, and the results are impressive, but you'd expect that from a professional grade software suite carrying a monthly subscription price.



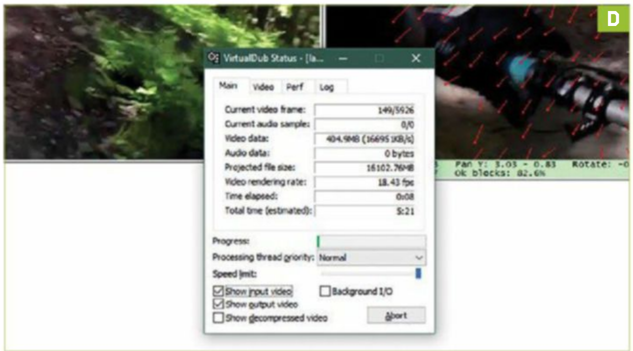
"Deshaker" on the list, and hit "OK." You'll see a big window full of options appear [**Image C**], which we're about to make sense of.

4 RUN A VIDEO ANALYSIS PASS

The tweaks you make in this window depend on what kind of camera you used to capture the video. GoPro footage, for example, benefits from selecting "Camcorder has a rolling shutter" on the left, and changing the value to around 85. If your video isn't from a GoPro, or you're not sure about shutter speed, leave this unchecked. Under "Pass 1 parameters," however, any footage benefits from choose the "Full" scale option in the drop-down menu. It works your system harder and takes longer, but it offers more precise results. We also had better results with "Detect zoom" left unchecked. Hit "OK," and back in the main VirtualDub window, head to "File" and "Run video analysis pass" [**Image D**].

5 RUN A SECOND PASS

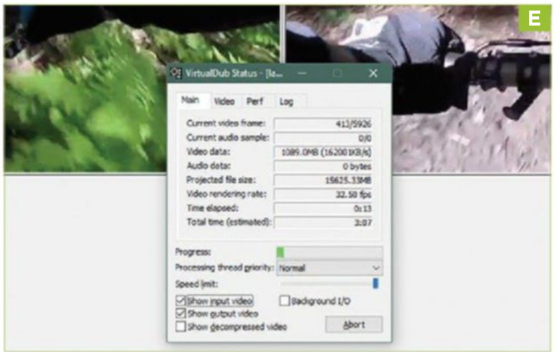
That pass takes a while, so let VirtualDub do its thing, then repeat the previous step to bring the Deshaker menu up once more. Now it's time to run a second pass, to improve results further. Leave the Pass 1 parameters as you set them before, and focus on Pass 2. This is where we eliminate the black border that often arises as a result of stabilization. Select "Use previous and future frames to fill in borders," then check the "Soft borders" box below, using a value of 10. Our GoPro trail riding footage features lots of changes in speed, so setting zoom to 0 in the motion smoothness values helps to avoid any noticeable changes in zoom. These are the results we found to be effective, but your footage might work better with different values, so experimenting is key. Now hit "OK" again, and you're all set [**Image E**].



D

VirtualDub Status - [la...

Current video frame: 149/5926
Current audio sample: 0/0
Video data: 404.9MB (16695 KB/s)
Audio data: 0 bytes
Projected file size: 16102.76MB
Video rendering rate: 18.43 fps
Time elapsed: 0:08
Total time (estimated): 5:21
Processing thread priority: Normal
☑ Show input video
☐ Background I/O
☑ Show output video
☐ Show decompressed video



E

VirtualDub Status - [le...

Current video frame: 413/5926
Current audio sample: 0/0
Video data: 1089.0MB (16200 KB/s)
Audio data: 0 bytes
Projected file size: 15625.33MB
Video rendering rate: 32.50 fps
Time elapsed: 0:13
Total time (estimated): 3:07
Processing thread priority: Normal
☑ Show input video
☐ Background I/O
☑ Show output video
☐ Show decompressed video

6 RENDER THE STABILIZED VIDEO OUT

All that's left is to save the newly stabilized file out. VirtualDub lets you save as an AVI in old or new formats, or in segments, the latter proving handy if you're working with a big, space-consuming file. Take a look at your new file [**Image F**], and compare it with the original. Check for a noticeable improvement, and for any odd frame pacing or zoom issues. And that's that: smoother, less headache-inducing vids for free. ⏻

F

Create a Striking Eclipse Montage

YOU'LL NEED THIS

LIGHTROOM AND PHOTOSHOP

Both come in Adobe's Photographer's Bundle (www.adobe.com).

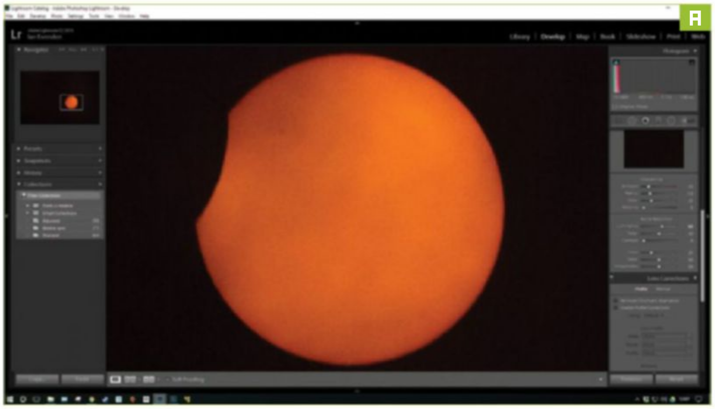
IMAGES

Photographs you took of the eclipse in August.

AUGUST'S ECLIPSE dragged a curved line of totality across the US, from northern Oregon on the west coast to the middle of South Carolina on the east. If you weren't lucky enough to be on this line, which also took in parts of Idaho, Wyoming, Nebraska, Missouri, Kentucky, and Tennessee, you will have seen a partial eclipse, which is still one of the greatest sights in the entire galaxy.

The total eclipse relies on the coincidence that our moon appears the same size as the sun in our sky, despite one being very large and far away, and the other being small and close. No other planet in the solar system has total eclipses, and it's likely to be a rarity across the universe. So, we hope you managed to get some pictures.

If, like us, you weren't quite sure of your camera settings when you went out, solar filter in hand, to record the eclipse, you might have ended up with some less-than-optimal results. Here's what you can do with them. –**IAN EVENDEN**



1 RAW MATERIALS

The image we're going to create will be a montage of photos showing the phases of the eclipse, from first contact to greatest coverage (we didn't see totality from our viewing position). We're going to start in Lightroom this month, because we shot our eclipse photos as raw files, and we need to do some noise reduction before exporting them as JPEGs. The app comes bundled with Photoshop CC as part of Adobe's Photographer's Bundle, but if you prefer a different raw decoder, you can use that.

» Lightroom is pretty good at noise reduction, but careful control of the slider is generally required to make sure you don't smear any fine detail in your image. In this case, however, there's little detail on the surface of the sun, thanks to wispy cloud that spoiled the view for us, and we don't care about the black space surrounding it. Therefore, we can just whack the Luminance slider up and not care about the results [**Image A**]. A little subtle shading from the clouds remains, which adds interest to the image.

2 NOISES OFF

We can quickly apply the same noise reduction to the other image we want to export, by right-clicking the edited image, and selecting "Develop Settings → Copy Settings." Click "Check None," and add a check in the "Noise Reduction" box. Then copy the settings. Decide which of the remaining images you want to include in the montage, select them with a left click and the Ctrl button, and paste the noise reduction in with a right click and "Develop Settings → Paste Settings." Keeping the images selected, export them as JPEGs using "File → Export." Keep them at their original size, because we're only going to want the sun and moon, not the dark space around them, and we might as well keep them as large as possible.

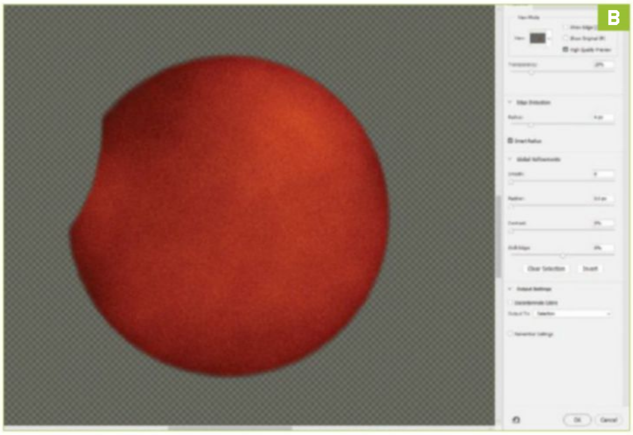
3 NATURAL SELECTION

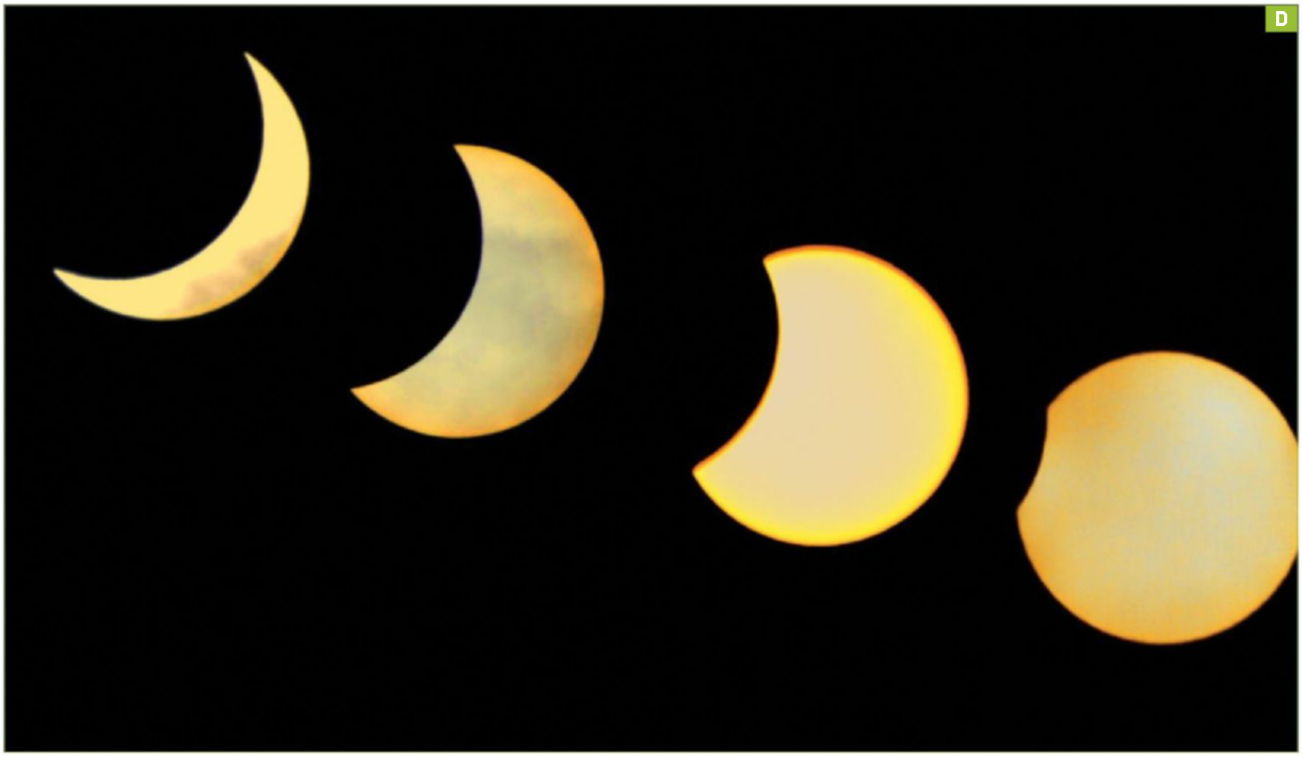
Open all your images in Photoshop as separate files. If, like we did, you've ended up with a lot of different colors on the sun, we can even them out so that the resulting montage doesn't look like a row of jelly beans. Photoshop has the facility to do this for us, but you need to select the sun in each image first. There are lots of ways you can do this, depending on how your image has come out.

» Our home-made solar filter (a circle cut from a sheet of proper solar safety film, squeezed between two cheap UV filters and a step-up ring) added some flare to the image, which isn't going to look that good in the final montage, so we'll be using the selection as an excuse to chop it out. We're going to use the Elliptical Marquee, then tidy it up in "Select" and "Mask" [**Image B**].

4 ELLIPSE ON THE ECLIPSE

This tool is a bit of a pain to use, because the ellipse it creates starts its edge at your mouse pointer's position, and it can be hard to get it the right shape. You can



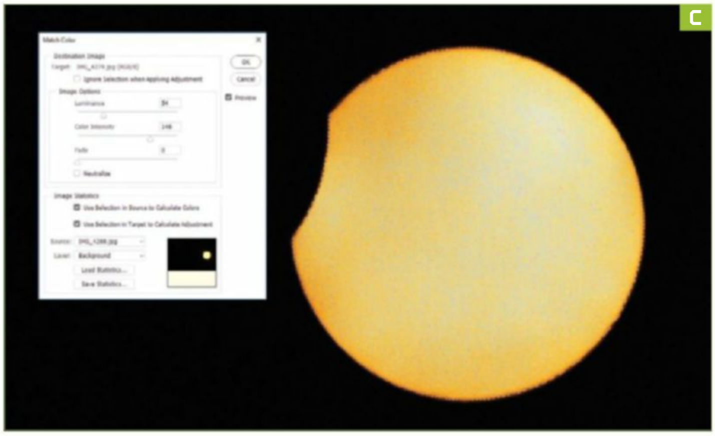


constrain it to a perfect circle with the Shift key. Concentrate on getting it the right size to completely surround your sun, and move it into position after you've released the mouse button. Alternatively, you can use the Quick Selection tool on the background followed by "Select → Inverse," if you've got a good clean division. Darken the sky around the sun using Levels' black point slider to sharpen the edge.

5

COLOR SCHEMING

Once you've got the sun selected on each of your images, it's time to even out those colors. Pick an image that's roughly in the middle of the color range, and remember its filename—this is going to be the source image. Select your first image, and go to "Image → Adjustments → Match Color." In the window that opens, make sure the "Ignore Selection" box isn't checked, and in the "Source" drop-down, choose the filename of your chosen source image [**Image C**]. Tinker with the sliders until you like what you see, then do the same thing with all your other images, except the chosen source image.



6

SUNSHINE STATE

To finish up, arrange all your suns on a black background—a straight line, especially diagonally across your image [**Image D**], can look good, but a curve has much more visual interest. Keep them selected, and you can simply drag and drop them into a new file, or on to the background of an existing image, whichever looks better to you. Use "Select → Modify → Feather" to slightly soften the edge of the sun if it looks too hard, and if there are any suns that are a slightly different size, shrink them down using "Edit → Free Transform," holding Shift so they're all the same size as the smallest—making any of them larger loses quality. Finally, flatten any layers in your image, and export your composite as a high-quality JPEG file ready to print.

PHOTOSHOP'S BROTHER

Lightroom doesn't always get the acclaim of Photoshop, but it can do much more than just decode your raw files. It's extremely good at managing your photo library, and its non-destructive editing (the edits aren't applied to the image until it's exported as a new file, meaning the original is never changed) can be applied to JPEGs as well as raws. Along with its spot-removal brushes, gradients to apply effects smoothly across an image, and ability to crop and resize photos, there's so much you can do in Lightroom that you might not even need to open Photoshop for some edits, especially when tidying up a large number of photographs that only require minor crops and tweaks.

BUILD IT

ZAK STOREY, REVIEWS EDITOR

The Big Ripper Rendering Rig

It's time to create some content—which means it's also time to build our monster machine

LENGTH OF TIME: **1–2 HOURS**

LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

IT'S ABOUT TIME we put those rendering processors to work, huh? We certainly think so—16 cores and 32 threads are just too good an opportunity to pass up. And with a renewed push to produce more video content for our online platforms over the coming months, it makes sense to piece together a workstation for our reviews editor that's a little more spec-driven than the Core i7-5820K and 32GB of DDR4 he has now.

At *Maximum PC,* our workstations are generally constructed out of parts we have on loan, they need to be flexible, and easy to take to pieces if certain components have to go back to their PRs. They also need to be versatile—from gaming, to standard office work, to photo editing, video rendering, and running through all manner of tutorials, our rigs have to be capable of doing it all.

This time around, our system is going to have a very large focus on video editing, so the monster component that is Threadripper is our processor of choice. Whether it's the eight-, 12-, or 16-core parts, both the connectivity and quad-channel memory support, combined with Ryzen's architectural prowess, make it the perfect match for our rendering aspirations, and anything else we want to throw at it.

So, what's the plan? Grab the 1950X, an Asus Prime X399 motherboard, 128GB of DDR4, a plethora of PCIe solid-state storage for scratch disk and OS use, and 20TB or so of hard drives for backup. No biggy, right?

POWER ZONE
PHANTEKS
NZXT
GTX

TRULY TITANIC

THE ONE THING WE REALLY ENJOY about speccing systems like this is just how much they change over the course of the planning stage. First, we were going to use the 12-core Threadripper, and we decided the Asus Zenith Extreme was our motherboard of choice. NZXT promised us a swanky new chassis exclusive (which, unfortunately, didn't arrive in time), so we swapped to the Fractal Design Meshify, but that wouldn't support the Asus Prime X399-A we eventually went with, so we finally settled on our old favorite, the Evolv ATX, instead. Couple that with the drop in effective memory frequency from 3,200 to 2,933, and that's one hell of a lot of different tweaks and changes to how this system was originally going to shape up.

It's a monstrous beast, with a price tag to match. It may not quite reach the heady heights of our Dream Machine from two issues ago (about $4K down on it on a pure system-to-system comparison), but it's still an outlandish amount of money to invest in any build.

The problem, as is often the case with these builds, lies with the storage and memory. As core counts have increased, and graphical prowess has accelerated headlong into the clouds, maximum memory capacity and hard drive prices have faltered. Look back two years, and the rate of improvement pales in comparison. That said, if you want to make this build more affordable, you could shave a good $2,000 off just by lopping off some of that excess storage. Even cutting down the memory to 64GB at 2,933 would save you nearly $700.

INGREDIENTS

PART		STREET PRICE
Case	Phanteks Enthoo Evolv ATX TG - Black	$180
Motherboard	Asus Prime X399-A	$350
CPU	AMD Ryzen Threadripper 16-Core	$1,000
Memory	128GB (8x 16GB) G.Skill TridentZ Series 3,200MT/s	$1,387
GPU	EVGA GeForce GTX 1080 Ti	$710
PSU	Be Quiet! Power Zone 1,000W	$200
Storage 1	1.2TB Intel 750 PCIe SSD	$893
Storage 2	1.1TB Crucial MX300	$345
Storage 3	2x 10TB HGST He10 7,200rpm	$720
Cooling	NZXT Kraken X62 280mm AIO, 2x Corsair ML 140 Pro, 4x Corsair ML 120 Pro	$280
OS	Windows 10 Home	$90
Total		$6,155

1

FAN-TASTIC

PHANTEKS'S EVOLV ATX TG has exceptional cooling support. Designed with liquid cooling in mind, it features a unique sliding radiator bracket in the roof, along with a whole ton of support for additional fan mounting. The front of the case allows for the external installation of up to three 120mm fans, between the chassis and the front fascia panel, typically used when installing a radiator. If you're installing fans without a rad in the front, to save space (for example, if you have two 3.5-inch hard drives installed below the PSU cover), you have to mount the fans from the rear instead of the front, as you would traditionally.

2

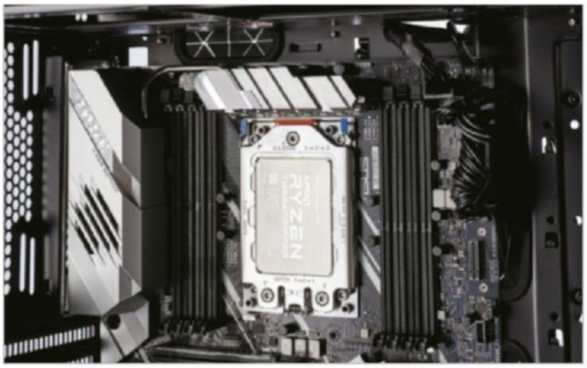
CABLE CONUNDRUMS

WE KNEW GOING INTO THIS that, by default, the Phanteks Enthoo Evolv ATX TG is only meant to support ATX-sized motherboards. It can accommodate the larger form factor, but only with careful planning. Because the mobo will cover the rubber grommets used for cable management, it's important in this scenario to install both the power supply and the cables you're going to need first, before installing and securing the motherboard in place. This actually gives us a good opportunity to work on our cable management ahead of time—important, given the Evolv ATX TG's clear rear glass panel.

3

TRIUMPHANT THREADRIPPER

INSTALLING THE 16-CORE beast is a little daunting. Upon purchase, you receive an Asetek bracket for your AIO, and a torque screwdriver. Using the screwdriver, you undo screw three, then screw two, then screw one. Let the first retention bracket lift up, then gently pull the two blue tabs up at the top of the socket. With the second retention bracket, slide out the plastic cover, then carefully remove the additional plastic cover protecting the socket. Then it's a case of sliding Threadripper into the second retention bracket (the one you removed the plastic cover from), until it clicks into place, then gently lowering it down on to the LGA socket, and finally resecuring the top retention bracket by tightening each screw until the included screwdriver clicks, going from screw one, to two, to three.



4

CLOSE ENCOUNTERS OF THE CABLE KIND

THIS WAS ALWAYS going to be a tight build, given that meaty mobo and the 280mm Kraken X62 wedged into the top of the chassis. Fortunately, thanks to the Evolv's removable radiator bracket in the top, this stage of the build is far less stressful, especially when installing the multiple cables going into the Kraken X62 CPU block, and routing fans into the motherboard. Simply slide the bracket out halfway, and you can easily reach around and gain access to the top of the board. It was also convenient when we first booted the board, because the stock BIOS on our review sample didn't support all 128GB at any frequency—one slide out, four sticks removed, a BIOS update and reinstall of the RAM later, and we're all good.

5

PCIE PROWESS

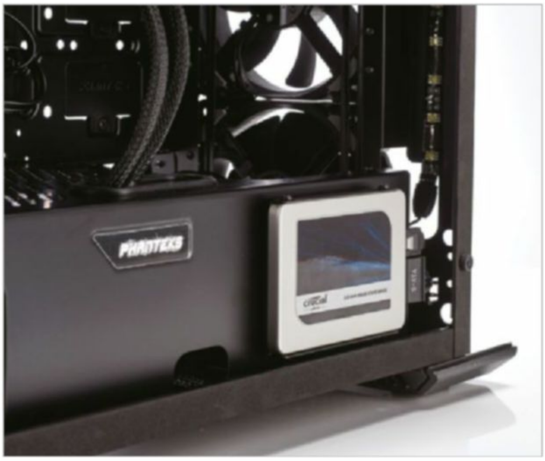
ALTHOUGH WE NOW have access to a couple of beautiful Titan Xps, we've decided to stick with the Nvidia GeForce GTX 1080 Ti—it's a beauty, and although it doesn't quite reach the pinnacles of performance that the Titan does, it's more than good enough for all our rendering and lunchtime gaming needs. We've also decided to pull out an old favorite—Intel's 1.2TB 750 PCIe SSD—for our primary storage drive and scratch disk. Although we're not massive fans of PCIe add-in cards like this, particularly for storage, the performance is exceptional, and that extra capacity is going to work wonders for us.

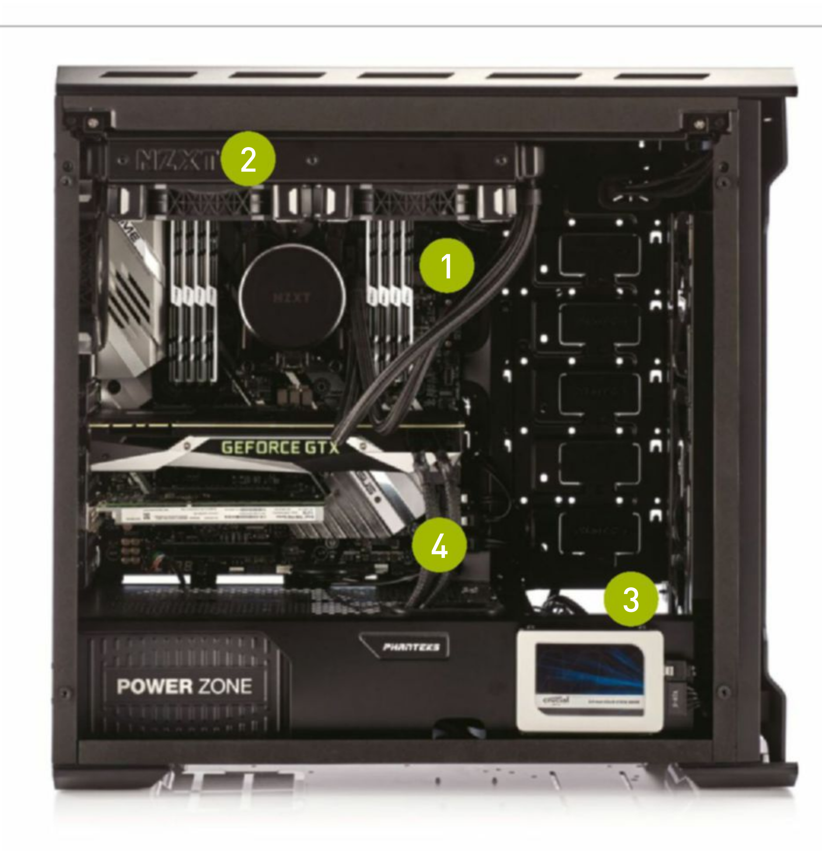
GEFORCE GTX

6

SMART MOUNTING SSDS

ANY OPPORTUNITY TO use a magnetic LED strip and we'll take it. Given the nature of this build, it doesn't really need the extra lighting inside—if anything, it's just adding additional power draw. That said, because power draw isn't a primary concern for us here, and it's going to be sitting on our desk, why not? We've also routed the cables for the Crucial MX300 around the right-hand side of the SSD, to ensure that we can retain the label in the correct orientation. It is a little snug to plug those cables in, but once installed, they're not going anywhere.





1 Seen from the side, it gives you a clear idea of just how big that motherboard is, covering up more than half the cable grommets in the process.

2 AMD's latest processors are actually fairly cool, so a 280mm AIO is plenty for a stock Threadripper.

3 The one thing we do wish is that the rear panel was made from smoked glass, instead of being transparent, as it lets a lot of light in from the back.

4 No flashy cables on here—just simple and stock. That said, those all-black cables do add a certain style to the build, matching the tubing on the AIO.

RIPPING UP THE OPPOSITION

IT'S NICE to have a build that comes together so smoothly. No hassle, no mess. The most challenging part was installing the three front 120mm fans from the inside, instead of externally. The radiator bracket in the roof made AIO installation a dream. The motherboard, despite pre-routing the cables, fitted snugly in place, and the fully modular 1,000W Be Quiet! PSU reduced cable clutter.

It's not flawless, but for all intents and purposes, it's perfect for the job at hand. The biggest decisions came from swapping and changing the spec list, and little else. And that's the problem: With Threadripper, AMD has introduced a way for mainstream consumers to gain access to HEDT features far greater than anything we've seen previously. With 64 PCIe lanes directly connected to the processor alone, allowing for up to four-way CrossFire or SLI at x16x16x16x16, it's staggering what you can do.

Alongside that, the number of cores is unprecedented within the industry. And although Intel does have solutions in the pipeline, they're coming in at a minimum of $700 more, as standard. And they don't support the insane levels of PCIe lane connectivity we've witnessed here with TR.

This puts Threadripper in a unique position because, although the core architecture isn't quite up to scratch compared to Intel's well-honed design right now, having that many cores, at such an affordable price, with a fairly weighty chipset behind it, makes it far more accessible and powerful than anything we've ever seen from Team Blue. For instance, ignoring our ridiculously pricey build here (thanks again, storage), you can knock up a fairly impressive 12-core, 24-thread, 32GB system for less than $2,500 relatively easily—check out our recommended build for that at http://bit.ly/TRCheaper.

Going forward, bearing in mind that these processor parts are based on AMD's EPYC server chips, it's entirely feasible that we could see core counts reaching even higher than the 16 cores we have today. A 32-core part coming out to directly combat Intel's 18-core Core i9-7980XE at the same price point may seem outlandish, but it's definitely something that's on the table for Team Red right now, and it would secure its absolute dominance in the high-end desktop domain.

Finally, let's make one thing clear: You can game, very comfortably, on Threadripper, outside of gaming mode, at 1080p, 1440p, and above, with relative ease. The difference between Intel and AMD is definitely there, but it's marginal (3–4 percent difference at most), and unless you absolutely must be at the cutting edge for frame rates, you're not even going to notice. ⏻

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi-Thread	987	3,362 (240%)
Cinebench R15 Single-Thread	196	160 (-18%)
TechARP's X264 HD 5.0.1 (fps)	21.93	72.68 (231%)
CrystalDisk QD32 Sequential Read (MB/s)	1,895	2,560 (35%)
CrystalDisk QD32 Sequential Write (MB/s)	949	1,334 (41%)
Rise of the Tomb Raider (fps)	41	91 (122%)
The Division (fps)	78	125 (60%)
3DMark: Fire Strike (Index)	15,026	22,819 (52%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM. All games are tested at 1080p on max settings, with HD texture packages installed.

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REVIEWS

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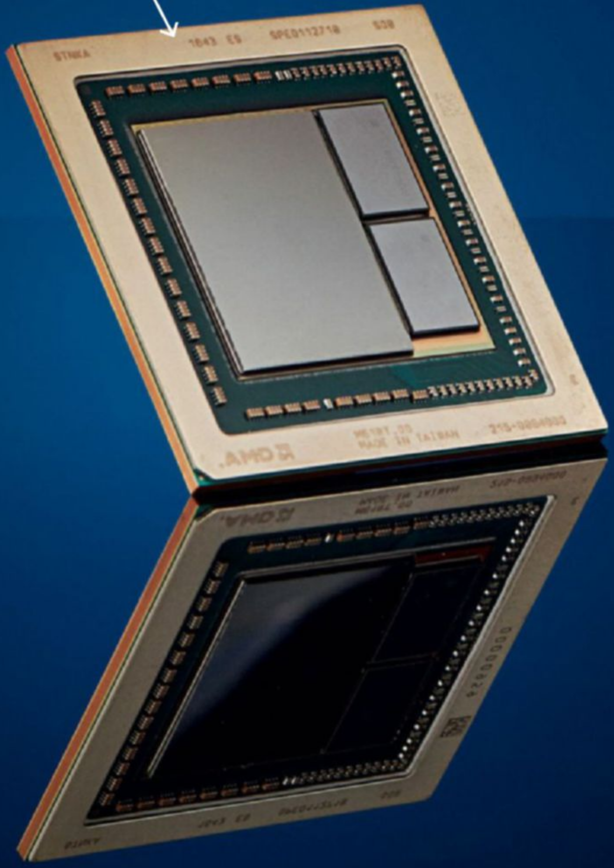

AMD RADEON RX VEGA 64 PAGE 78

AMD Ryzen Threadripper 1920X
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Packing a dozen cores, the Threadripper 1920X is truly impressive.

AMD Ryzen Threadripper 1920X

A 12-core champion confidently enters the fray

IT'S AN AWESOME TIME to be a PC enthusiast. Just six months ago, there was barely a single AMD CPU worth getting out of bed for. Now, we can hardly keep up with all the crazy new models, each with insane core counts and the promise of ever more preposterous levels of performance.

Enter the AMD Ryzen Threadripper 1920X. We had our dirty paws on AMD's flagship, the monstrous 16-core 1950X, last issue, so it was time to throw the $800 offering on our bench instead. The 1920X packs a mere 12 cores and 24 threads, but that still makes for an absolute beast of a PC processor. One capable of on-paper feats of parallel processing that simply weren't available until AMD shook things up with its awesome Ryzen architecture.

As for the specifics, the 1920X clocks in at a 3.5GHz base clock and 4GHz Turbo. Those are very healthy clocks indeed for a chip with so many cores, and that reflects AMD's clever approach with the Threadripper lineup, which involves a pair of eight-core processor dies in a single package. In other words, given that mainstream eight-core Ryzen CPUs have no problem clocking up to 4GHz, it should be no surprise that Threadripper chips are also capable of a similar figure.

Of course, effectively cramming two CPUs as powerful as Ryzen into a single package has certain ramifications in terms of power consumption, but more on that in a moment. First, it's worth recalling some of the platform niceties that come with these epic Threadripper chips. Not only do you get quad-channel DDR4 memory support, but also no fewer than 60 PCIe lanes. This is some very serious computing hardware.

That's something that socks you squarely between the eyes the moment you run some benchmarks. This thing flies. It murders Cinebench in multithreaded mode, with 2,308 points. The single-thread score of 152 is pretty tolerable, too, thanks to that 4GHz top Turbo speed. The raw memory bandwidth is also mega, hitting around 60GB/s for reads and writes. Ouch.

If there is a price to be paid for this raw computational muscle, it's power consumption. At idle, our 1920X ticks along at a reasonable 67W. Under full CPU, that leaps to 243W. But we don't have a major issue with that. If you want a lot of performance, you have to pay for the power.

What you might not be so willing to put up with is Threadripper's mediocre gaming performance. The clever modular architecture AMD has come up with for Zen, complete with its innovative Infinity Fabric interconnect, is hugely effective for many parallelized workloads. But it does create certain latencies, thanks to the way the cores and cache memory are arranged. Those issues are magnified when you have two separate CPU dies in one package, as is the case here.

To offset that architectural shortcoming, AMD has cooked up a special Game Mode for Threadripper CPUs, which does two things. First, it disables one of the CPU dies altogether, leaving you with effectively a conventional single-die Ryzen processor. It also switches the chip's memory mode to NUMA, which restricts a game's memory footprint to locally-connected RAM, further reducing latency issues.

The upshot, in theory, is that Threadripper in Game Mode performs on par with a mainstream single-die Ryzen processor of similar configuration. That's our experience in practice. Run a game such as *Total War: Attila* on the 1920X in the fully-enabled 12-core Creator Mode, and it can be hideously stuttery. In Game Mode, it's just a little stuttery, like a regular Ryzen CPU. It's just a pity that you must reboot the system fully to jump between modes.

Not that the patchy gaming performance matters. This 12-core chip is hardly a cost-effective way of gaming. For everything else, it's absolutely killer. **–JEREMY LAIRD**

VERDICT

9

AMD Ryzen Threadripper 1920X

➕ **RIPPED** Crazy multithreaded performance; high clock speeds, too.

➖ **TORN** Pretty power-hungry; not a great choice for enthusiast gamers.

$799, www.amd.com

BENCHMARKS

	AMD Ryzen Threadripper 1920X	Intel Core i9-7900X
X264 Benchmark (fps)	27.67	**45.12**
Cinebench R15 Single (Index)	152	**180**
Cinebench R15 Multi (Index)	**2,308**	2,218
Fry Render (Seconds)	127	**94**
AIDA64 Memory Latency (ns)	121.6	**71.8**
Total War: Atilla (fps)	37	**41**
Far Cry Primal (fps)	75	**77**
3DMark: Fire Strike (Index)	14,435	**18,302**
Maximum OC (GHz)	3.9	**4.6**

Best scores are in bold. Our test bed consists of an Asus X399 ROG Zenith Extreme, a Gigabyte Aorus X299 Gaming 9, 32GB (4x 8GB) of Corsair Dominator Platinum DDR4, an Nvidia GeForce GTX 1080, and a 500GB Samsung 850 Evo. All games were tested at 1440p on the highest graphical profile.

SPECIFICATIONS

Base Clock	3.5GHz
Turbo Clock	4.0GHz
Cores	12
Threads	24
Lithography	14nm
Cache	32MB
Memory Support	DDR4 2,666MHz
Memory Channels	4
Max PCIe Lanes	60
TDP	180W

AMD Radeon RX Vega 64

All bark and no bite?

WELL, FOLKS, WHAT CAN WE SAY? AMD has well and truly screwed the pooch on this one. It's been 16 months (at time of writing) since Nvidia launched its high-end Pascal GPU lineup, featuring the GTX 1080 and GTX 1070, and 12 months since AMD launched its Polaris architecture. In that time, we've seen marketing ploys, press events, and more, all labeling Vega as the new king of compute, the prodigal son, even demolishing Nvidia's yet-to-be-released Volta architecture in some cases.

What we're left with, then, is a check that the mouth can't cash. From the get-go, we knew something was up—the fanfare that surrounded the launch of Threadripper was suspiciously absent when it came to Vega's arrival. The press reps fell quiet, there were no unboxing videos, no launch events, all was quiet. Our sample arrived in the post, not with the flurry of notifications that we're used to, but with silence. We threw it on the bench and, alas, our suspicions were confirmed.

Performance wasn't as impressive as we first hoped. It's a card that isn't quite capable of beating the GTX 1080, never mind the heady heights of Nvidia's 1080 Ti. At 1080p, performance was solid enough: We saw scores of 48fps in *Total War: Attila*, 103 in *Far Cry Primal*, 104 in *The Division*, and 62 in *Rise of the Tomb Raider*. Bump up to 1440p, and you're still hitting over 60fps in *Primal* and *The Division*, and then 40-ish at 4K. Compare it to the GTX 1080, however, and you'll notice that performance is ever so slightly lacking. Synthetic benchmarks score well, but aside from that, the RX Vega 64 falls slightly behind in all of our benchmarking suite.

Take it overclocking, however, and you can expect an extra 100MHz out of the core, and 200MHz out of the memory—not a huge amount, but still enough to draw those Fire Strike scores up by an extra 500–2,000 points where it counts. Unfortunately, voltage control, as with the Fury X, isn't available right now, so we can't push it further; but, to be honest, you probably wouldn't want to.

The biggest problem by far is the power draw. At stock, under load, our reference GeForce GTX 1080 in our test rig draws 252W from the wall. Compare that to Vega, and the difference is staggering: 403W under load. That's 151W more, and 49W more than even our reference GTX 1080 Ti. That's no small amount. We can't say for sure, but the amount of voltage AMD has had to throw at the architecture, purely to get even vaguely comparable performance up against its Nvidia rivals, makes us doubt whether we're likely to see anything competitive from team red.

Then there's the price. Partly due to its crazy-high hash rate drawing every wannabe cryptocurrency miner this side of the Atlantic to it, and another part due to a lack of available stock on AMD's part, Vega 64 is available right now for $680 for the standard reference design—limited to one per customer. If that isn't to your liking, you can pick up a GeForce GTX 1080 for $510 instead. Hell, a GTX 1080 Ti is only $70 more than Vega, and that nets you an EVGA aftermarket design, with a 20MHz overclock, and a triple-fan cooler, plus average performance over 22 frames higher in most titles.

Look, we don't want to rage at AMD. We're not doing it just for the sake of it. The company needs to do well—Nvidia needs real competition, because it drives innovation; we've already seen this with Intel and Ryzen. But Vega 64 has fallen well short of the mark and, given its current availability, price, performance, and power draw, the hype train has left both the station and Vega far behind. For $170 less, you can get similar, if not better, performance by going with team green, and that genuinely saddens us. **–ZAK STOREY**

VERDICT 6

AMD Radeon RX Vega 64

⊞ **VEGAS** Strong GTX 1080-like performance; good thermals; nice design.

⊟ **VAGRANT** Horrendous power draw and pricing; too little too late

$680, www.amd.com

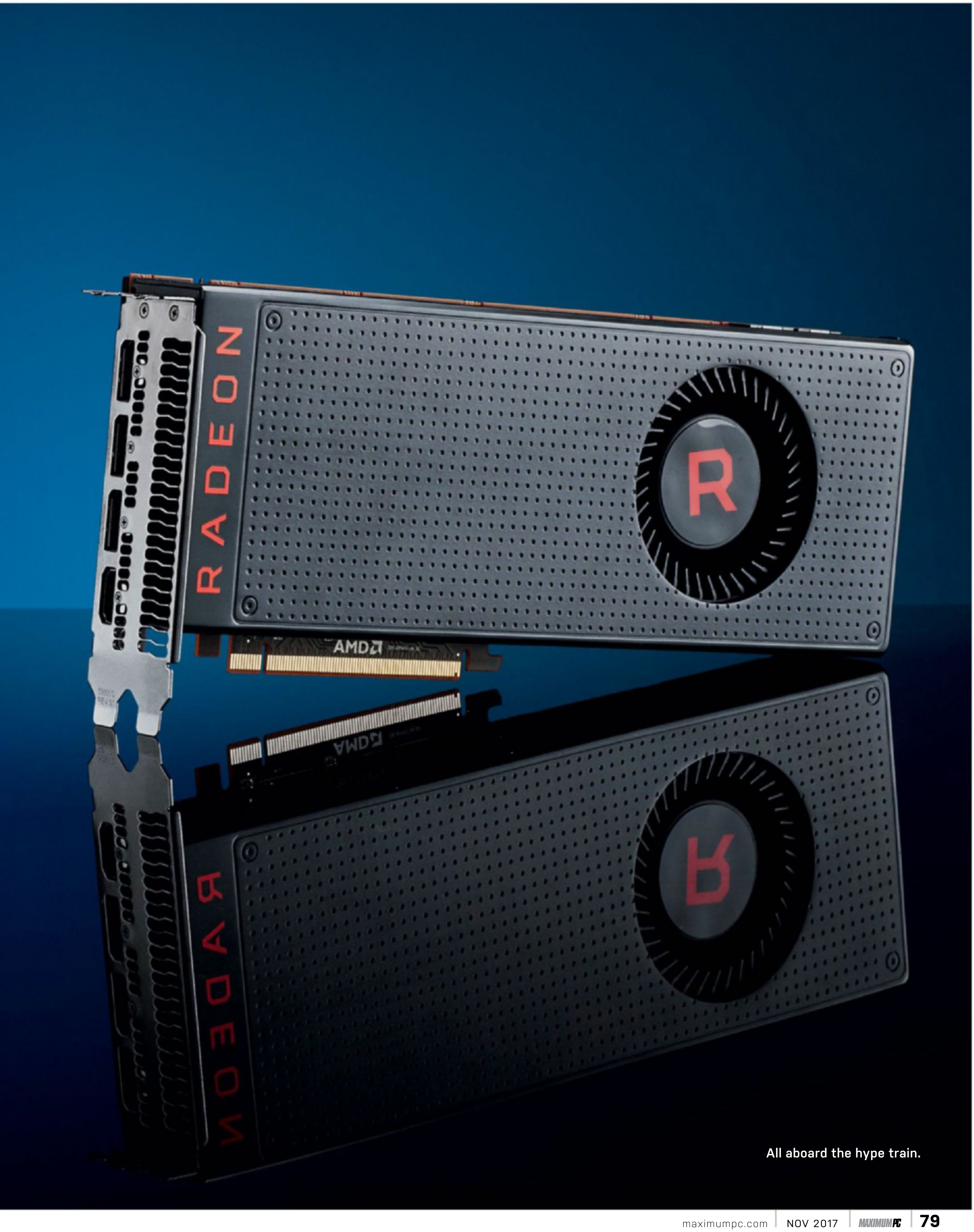
BENCHMARKS

	AMD Radeon RX Vega 64	Nvidia GeForce GTX 1080	Nvidia GeForce GTX 1080 Ti
Total War: Attila (Min/Avg fps)	18/27	23/40	**36/55**
Far Cry Primal (Min/Avg fps)	63/76	65/77	**86/101**
The Division (Min/Avg fps)	41/75	39/73	**44/95**
Rise of the Tomb Raider (Min/Avg fps)	15/40	16/42	**23/57**
3DMark: Fire Strike Extreme (Index)	9,566	9,371	**12,037**
3DMark: Time Spy DX12 (Index)	6,758	6,537	**8,307**
Power Draw Idle (Watts)	66	48	**47**
Power Draw Load (Watts)	403	**252**	354

Best scores are in bold. Our test bed consists of an Intel Core i7-7700K, 16GB of Corsair DDR4 @ 2,400, an Asus Maximus IX Hero, and a 500GB Samsung 850 Evo SSD. All games are tested at their highest graphical profile, with AA turned up, at 1440p.

SPECIFICATIONS

GPU	Vega
Lithography	14nm FinFET
Transistor Count	12.5 billion
Stream Processors	4,096
Texture Units	256
ROPS	64
Core Clock	1,274MHz
Boost Clock	1,546MHz
Memory Capacity & Type	8GB HBM 2.0
Memory Speed	945MHz
Memory Bus	2,048-bit
TDP	295W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All aboard the hype train.

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Intel Core i7-7820X

Why some CPU cores are more equal than others

FUNNY HOW FAST things change. Eighteen months ago, eight cores was as good as it got for desktop PC processors. Not now. In this brave new post-AMD Ryzen world, it's half as many cores as AMD now sells you in a single CPU. It's not even half as many as Intel is planning by the end of 2017.

The flip side goes something like this: If eight cores is no longer exotic, it should be affordable, right? When it comes to AMD's Ryzen processors, that's an affirmative. As we go to press, Newegg happens to have a sale on the entry-level AMD Ryzen 1700 eight-core chip, just squeezing it in under $300. That is simply awesome.

It's also where we'd hardly blame you for taking issue with the new Core i7-7820X. It's Intel's latest eight-core chip, and it arrives with an official retail price of $599. That's not only double the cost of that fire-sale Ryzen processor, it's also more than $200 more than the next CPU down in Intel's new Skylake-X range, the six-core Core i7-7800X. Of course, not all CPU cores are equal. Hold that thought while we look at the 7820X's vital statistics.

Beyond the eight cores and Hyper-Threading-enabled 16 threads, the headline numbers look good. There's a 3.6GHz base clock, 4.3GHz Turbo clock, and 4.5GHz TurboMax speed. In other words, the 7820X packs a healthy combo of core-based parallelism plus excellent single-core clock speeds. You also get 28 PCI Express lanes. OK, that's way fewer than the 64 you get with an AMD Threadripper chip, and it's a lot fewer than the 44 lanes Intel hooks up to the next CPU up in its own Skylake-X lineup, the 7900X. But it's probably enough for all but the most demanding of system configurations.

Of course, the other major feature that comes with the 7820X is Intel's peerless CPU core architecture. AMD's Ryzen cores are very good, but they're not quite this good. Which is why the 7820X blows every eight-core Ryzen CPU we've tested out of the water. OK, it's only a little ahead of AMD's fastest eight-core model, the Ryzen 7 1800X, in Cinebench's multithreading mode, and the 7820X only has a small advantage for video encoding, too. But it batters the AMD chip by 194 points to 159 in Cinebench's single-threaded mode. That's over 20 percent more performance.

In certain multithreaded workloads, it's a lot quicker, too. Fry Render gives the 7820X a huge 31 percent advantage for rendering. As for gaming, well, the raw numbers would have you thinking there's not much in it. In practice, AMD's modular Zen architecture can be stuttery in some game titles. It's not a widespread issue, but Intel remains the obvious choice for consistently smooth performance in the widest number of games.

All of that applies to the 7820X running at standard clock speeds. Thanks to an unlocked CPU multiplier, you have easy access to cranking up the frequencies, too, if that's your bag. In the end, then, Intel's marketing boys aren't completely crazy. Yes, the 7820X looks expensive in terms of pure core count, when you can grab an AMD eight-core CPU for half the money, but there's more to CPU performance than mere core count. Intel's cores remain the best you can buy on a per-core basis, and that, combined with healthy clock speeds, means the Core i7-7820X is quicker than any current eight-core AMD processor.

That goes some way to justifying the price. Whether it gets you over the line and makes the 7820X a completely compelling proposition will come down to your usage scenario. If all you care about, for instance, is video encoding, this chip probably isn't for you. But as an all-round workhorse, it's a seriously nice CPU. **–JEREMY LAIRD**

BENCHMARKS

	Intel Core i7-7820X	AMD Ryzen 7 1800X
X265 Benchmark (fps)	**30.45**	27.89
Cinebench R15 Single (Index)	**194**	159
Cinebench R15 Multi (Index)	**1,741**	1,612
Fry Render (Seconds)	**122**	161
AIDA64 Memory Latency (ns)	**84**	98
Total War: Atilla (fps)	**40**	39
Far Cry Primal (fps)	**76**	75
3DMark: Fire Strike (Index)	**18,201**	16,433
Power Draw Idle (Watts)	83	**56**
Power Draw Load (Watts)	197	**182**

Best scores are in bold. Our test bed consists of an Asus X299 Prime-A, an Asus Crosshair VI Hero, 32GB (4x 8GB) of Corsair Dominator Platinum DDR4, an Nvidia GeForce GTX 1080, and a 500GB Samsung 850 Evo. All games were tested at 1440p on the highest graphical profile.

VERDICT

8

Intel Core i7-7820X

⊞ **IT'S AN ANIMAL** Fantastic all-round performance; unlocked multiplier for easy overclocking.

⊟ **ANIMAL FARM** Cheaper eight-core CPUs exist; bang for buck lacking in some apps.

$599, www.intel.com

SPECIFICATIONS

Architecture	Skylake-X
Socket	LGA2066
Cores/Threads	8/16
Clock Speed	3.6GHz base, 4.3GHz Turbo, 4.5GHz TurboMax
Cache Memory	11MB L3
Lithography	14nm
Memory Support	Quad-channel DDR4-2666
PCI Express Lanes	28
TDP	140W

acer
PREDATOR
WFHD
2560 X 1080
tobii
PREDATOR

Insanity made manifest.

Acer Predator 21 X

Engineering triumph, or garish cost?

HOW MUCH IS TOO MUCH? Or, why not more? That's the question Acer's Predator 21 X asks just by existing. An exercise in excess, the 21 X is a behemoth of a laptop—if you can call it one—that crams every possible bell, whistle, and kitchen sink you can think of inside its not-so-svelte frame. Except when it doesn't. 21-inch curved ultrawide screen? Check. Full-size mechanical keyboard? Check. Top-end internals? Check. High-resolution panel? Nope.

Before we get to that questionable design choice, let's talk about what it's like to use a laptop that's upward of four times more expensive than a high-end desktop. Of course, laptop is a bit of a misnomer. Sure, it's an all-in-one system with a mouse pad, keyboard, and screen that folds down in a clamshell—you know, the traditional hallmarks of what we call a "laptop"—but this is not the kind of machine you'd situate on your lap. First off, it weighs more than 18 pounds, not including the two massive 330W power bricks. That alone should be enough reason, but there's also the front-situated keyboard that makes general use awkward, not to mention the massive fans spitting hot air out of the back. Ouch!

Portable desktop-replacement would be more accurate. But even then, is the Predator 21 X that portable? It's not exactly the kind of rig you can toss in a backpack and take through airport security. In fact, the system ships with its own custom Pelican carrying case—a gargantuan wheeled box that you might expect to house a photographer's entire livelihood. The (even larger) cardboard box it shipped in was so big that we were able to fit our editor in chief, Tuan Nguyen, completely inside. Solid Snake would have been proud.

All of this is to say that the Predator 21 X is hardly portable, which for a laptop, amounts to a contradiction that in many ways sums up the machine as a whole. This is the system that asks "why not?" Yet, we find ourselves asking "why?" For all the power and engineering inside, it's saddled with a comparatively low resolution panel that clocks in at a mere 1080p.

About that power. The Predator 21 X is outfitted with a nice suite of top-end internals. An Intel Core i7-7820HK pairs with 64GB (because why not?) of DDR4-2400 RAM. Primary storage is handled by two 512GB PCIe SSDs in RAID 0 (again, why not?), with a backup 1TB SATA HDD for good measure. And for pixel-pushing, two GeForce GTX 1080s in SLI. Why not, indeed.

If you've paid attention to some of our previous dual-GPU system reviews, you may remember a common thread: SLI does not play nice with 1080p. Most dual-GPU laptops we've tested before sported 4K screens, and top-end dual-GPU rigs are usually similarly intended for higher-resolution gaming—if not at 4K, then 1440p at 144Hz. And yet here we are: two GTX 1080s in SLI chained to a criminally low resolution 1080p panel.

Now, it's worth noting that the Predator 21 X's panel is indeed a 21:9 ultrawide format, meaning the actual resolution is 2560x1080, as opposed to the standard 1920x1080. But even so, we found the lower resolution's issues with SLI performance to exist nonetheless. In some games, SLI played nice and offered frame rates in the realm we expected. *The Division,* for example, consistently returned a score of 115fps with SLI enabled using its built-in benchmark on the highest available graphics preset, as opposed to 81fps without SLI. *Far Cry Primal* was a different story. It also scored around 81fps without SLI, but the frame rate dropped down to an average of 63fps with SLI turned on.

Rise of the Tomb Raider had the same issue. Without SLI, the game's three-part benchmark returned an average of 103fps. With SLI, that score dropped to 80fps. To make matters even more confusing, enabling DirectX 12 seemed to help SLI performance—raising the score to 127fps on average, but also introducing extremely noticeable bouts of lagging frames. Not exactly an enjoyable viewing experience.

All of this is to say: why? For all the excessive "shoot-the-moon" attitude that went into the Predator 21 X, why not go all the way and outfit it with a proper screen? It doesn't even have to be 4K—we'd be plenty happy with a high-refresh-rate 1440p panel. But 1080p? That's unacceptable. For $9,000, we expect the best. **-BO MOORE**

BENCHMARKS

	ZERO-POINT	
Cinebench R15 (Index)	682	765 (12%)
TechARP x264 (fps)	15.17	16.94 (12%)
CrystalDiskMark 4K Read (MB/s)	44	33.16 (-25%)
CrystalDiskMark 4K Write (MB/s)	162	112.9 (-30%)
Far Cry Primal (fps)	37	63 (70%)
The Division (fps)	33	115 (248%)
Rise of the Tomb Raider (fps)	42	81 (93%)
3DMark Fire Strike (Index)	6,583	20,470 (211%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our laptop zero-point is the Asus G752VT-DH72, with an Intel Core i7-6700HQ, GTX 970M, and 16GB of DDR4. *Rise of the Tomb Raider* tested at very high settings with SMAA at 1080p

VERDICT 7

Acer Predator 21 X

+ EMPOWERED Impressive spec; engineering triumph; 21:9 panel.

– SOURED Price, price, price; not-so-perfect 1080p screen.

$9,000, www.acer.com

SPECIFICATIONS

Processor	Intel Core i7-7820HK @ 2.9GHz
Graphics	2x Nvidia GeForce GTX 1080 SLI
RAM	64GB DDR4-2400
Screen	21-inch 2560x1080 IPS G-Sync
Primary Storage	2x 512GB M.2 PCIe SSD in RAID 0
Secondary Storage	1TB 7,200rpm HDD
Keyboard	Full mechanical RGB
Battery	Eight-cell Lithium-ion 6,000mAh
Connectivity	1x DisplayPort, 1x HDMI, 4x USB 3.0, 1x USB 3.1 Type C, audio line-in, headphone jack
Weight	18.7lb

Asus Designo MX34VQ

The latest Asus screen ups the slickness ante

REMEMBER WHEN Asus more or less just made motherboards, or at least that's how it seemed? No, us neither. Today, the Taiwanese megacorp has its fingers in so many pies, it's hard to keep up. More to the point, just when you thought Asus's product offerings couldn't become more polished and consumer-friendly, along comes the Designo MX34VQ. It's an awfully long way from those frills-free circuit boards of old.

It's also far more grown-up than Asus's existing ROG Swift premium monitors, they of the projected logos and gamer-centric shtick. Instead, this Designo model feels like a carefully aimed headshot at the likes of Samsung's CF791. As it happens, the MX34VQ shares several key specs with that Sammy screen. For starters, both are 34-inch super-wide monitors with 3440x1440 native resolutions. They're both curved and both support 100Hz refresh and AMD's FreeSync tech. Then there's a very similar high-end consumer electronics feel to the design of both. But what really marks them out as peas from a similar pod is the use of VA as opposed to IPS panel technology.

Indeed, with Asus reportedly sourcing its VA panel from none other than Samsung, you might suspect that they actually share the same panel. However, the Samsung screen sports a tighter 1500R radius to its curve versus the Asus's slightly less extreme 1800R bend. The other major differentiator is the Samsung's quantum dot technology to boost the fidelity of its backlight. Whatever, VA is always an intriguing choice due to the pros and cons it offers versus the ubiquity of IPS.

For starters, with VA, you get better outright contrast performance. In this case, a static contrast ratio of 3,000:1. Current IPS monitors tend to top out at 1,000:1. The reality isn't as simple as the VA solution being three times better than IPS, but the advantage is real enough. On the downside, VA panels don't offer the same super-wide viewing angles as IPS, and pixel response tends to be a little slower.

In practice, that's pretty much how it plays out. The MX34VQ has lovely, inky blacks, with very little evidence of light bleed. However, in its standard factory calibrated form, the MX34VQ also exhibits signs of crushing shadow details, which is a common trait in VA panels, and the flip side of that awesome contrast performance. In test animations, that characteristic VA inverse ghosting can also be seen, though it's much less of a problem in practical use. Likewise, there's no getting round the fact that the viewing angles aren't as broad as an IPS panel. Most of the time, that's fine. Just occasionally, however, you'll view images that are particularly sensitive to color shifts, and it will bug you just a bit.

That said, the 100Hz refresh makes for a lovely gaming experience. The high contrast and the rich if not quite quantum-dot-competitive colors make for a real spectacle in games such as *Witcher III*. OK, you don't quite get the same fluidity and sharpness of input response as a 144Hz or 240Hz monitor, but you do get most of the benefit of such screens versus a standard 60Hz monitor. Once you go high refresh, you won't want to go back, even for just shuffling windows around on the desktop—60Hz suddenly looks so very old.

Elsewhere, Asus has added a few nice extras, including Qi wireless charging in the base of the stand. That's very cool if you happen to have a phone that supports wireless charging. All, therefore, is largely well? Not quite. The MX34VQ's stand only supports tilt adjustment, it sits very low, and there's no VESA support to fall back on. Apart from that, it's a very appealing panel, albeit at a price. **–JEREMY LAIRD**

VERDICT
8

Asus Designo MX34VQ

+ AHEAD OF THE CURVE Lots of lovely contrast; fab 100Hz refresh; awesome industrial design.

− MIND BENDER VA panel has drawbacks; no stand adjustability or VESA support.

$800, www.asus.com

SPECIFICATIONS

Panel Size	34-inch
Native Resolution	3440x1440
Pixel Density	110 ppi
Panel Type	VA
Maximum Refresh	100Hz
Response	4ms
Contrast	3,000:1
Display Inputs	HDMI x3, DisplayPort
Connectivity	USB
VESA Mount	No
Warranty	Three years

harman kardon

The Designo MX34VQ might just be Asus's best-looking monitor yet, design-wise.

SteelSeries Rival 310

A mouse that won't break the bank, but might help you break gaming records

YOU CAN PAY A LOT for a gaming mouse. Over 200 bucks, in fact. And PC gaming—indeed, PC building, too—is one of those hobbies where, if you're using cheaper gear, you can feel like you're being left behind. As though those people who buy the $200 mice, or the really expensive PSUs, or some colossal gold-plated case are having more fun than you are with some mid-range equipment.

This is not the case. Sure, spending that much money on an input device might make you feel good—and mice are important; they're the indispensable translator of your movements and wishes into the twitch of gunsights or the pixel-perfect swirl of a digital paintbrush—but you can feel good without splashing that kind of cash.

Take the Rival as an example. Logitech and Razer will relieve you of more green folding stuff for their products, but you won't necessarily get a great deal more for your money. SteelSeries's pair of revamped rodents (the ambidextrous Sensei, which has almost identical specs just in a different shell, is up to version 310, too) certainly punch above their cost.

Take the new sensor: The TrueMove 3 from PixArt offers one-to-one raw tracking, which sounds like some ludicrous marketing nonsense, until you start thinking about who would actually need it. That person is the owner of a very large, high-resolution monitor, the kind of thing we all aspire to, on which the smallest deviation of mouse movement is magnified into a distinct jink.

The one-to-one tracking means the distance the sensor moves on your desktop is mirrored exactly on the screen, with as little processing involved as possible, and therefore no lag. The Rival can go as high as 12,000 cpi, giving exceptional sensitivity for those who need it, and covering a decent bit of 4K real estate for every inch moved.

Beneath the mouse, this remarkable sensor sits rather plainly—a small hole in the plastic base is all that betrays its presence. We rather like this understated approach to design; where other companies would have picked it out in orange, you'll never see "12,000 CPI" sprayed across the back of the unit. All we get here is the SteelSeries logo, which looks rather like a sniper drawing a bead on Ronald McDonald (gambling debts to the wrong people, most likely) embossed into the base, and lit up again on the back, right under your palm. Light also leaks out from around the wheel, which is a thick, grippy one, with enough click to it that you're left in no doubt as to whether it has gone round a notch or not—essential when using it to switch weapons.

Elsewhere, we're firmly in the land of the matt black plastic people—but, again, SteelSeries has a trick up its sleeve. All the materials have been chosen for their light weight, and the plastic is fiber-reinforced. The shell is fingerprint-resistant, too; handy if you've ever been caught by the police after CSIs dusted your mouse. All this gets the weight down to a shade over three ounces.

The gray silicon side grips are certainly grippy, and the main buttons clicky—they're separate from one another and the rest of the body, and made from the same fingerprint-repelling plastic, which is slightly textured. They're very pleasant places for your fingertips to hang out, as long as you're right-handed. Underneath are Omron-designed switches rated for 50 million clicks, and the restrained lighting does all the usual Prism-enabled tricks across your peripherals, the software up to SteelSeries's usual standards, and the 32-bit CPU onboard showing no signs of slowing anything down.

"From the creators of the #1 gaming mouse," shouts the box quote from *Maximum PC*. And with its new sensor and complete failure to put a foot wrong, the new Rival should be snapping at that mouse's heels. **–IAN EVENDEN**

VERDICT 8

SteelSeries Rival 310

STEEL Excellent new sensor; nice textured finish; restrained design.

HEEL Lacks excitement; for right-handers only.

$70, http://steelseries.com

SPECIFICATIONS

Sensor	Optical
Sensitivity	100-12,000 cpi
Sensor Model	PixArt TrueMove 3
Polling Rate	1ms
Programmable Buttons	6
LEDs	2-zone 16.8 million colors
Cable Length	6.5 feet
Weight	3.1oz

SteelSeries Apex M750

A keyboard for those who love life's little luxuries

WHEN AUTOMOBILE MANUFACTURERS design a new car, they don't just focus on the tiny explosion box under the hood. Every aspect of design is taken into consideration, every sense of the potential owner checked off. And while SteelSeries hasn't imbued the Apex M750 with New Keyboard Smell (though, there's an idea for future editions) it's covered just about every other base. Visually, for example, it looks absolutely magnificent. Smooth curves have been panel-beaten out of its aircraft-grade aluminum base, though it's so richly coated that only the weight and overall sturdiness really give away that this matt black slab is made of metal. There's nothing superfluous or even slightly gamer-centric about its outward appearance; no harsh angles, no obnoxious media keys, just smooth lines, and a standard layout with readable, well-lit keys.

SteelSeries's Prism lighting system has long been one of our favorites, and it's in full effect here, with a stack of reactive and wavy RGB functions that can be switched (and stored) on the keyboard itself, or more delicately customized through the SteelSeries Engine software. In truth, many of these are more suitable as showroom demos than anything you'll want on your desk, but damn if they don't look impressive for the five seconds you'll have them active. SteelSeries's new QX2 mechanical keyswitches, debuting here, are housed in transparent plastic, which allows the light from the upper-mounted LED to bleed through to the bottom, creating a strong glow, even with a black base beneath. They're designed to be fully compatible with Cherry keycaps, though the included caps (despite their slightly sharp edges) are smart enough that you won't want to replace them any time soon.

One of the more subtle aspects of motor manufacturing is sound. The engine note, the clunk as you slam the door—it's all designed just as carefully as the rest of the auto. We can't help but feel that SteelSeries has done its own audio engineering work on the rattle of these keys. The QX2s are, technically, silent—press them gingerly enough and take advantage of the half-press actuation distance, and there's little to no noise. Hammer them in normal typing, though, and you're in for a true aural treat. It's a seriously satisfying clatter, which we'd rate above most other keyboards, and even if you really go to town on it, there's none of the harmonic spring-ringing that plagues some other switches.

Not that these switches are perfect for every user, though. They feel amazing to use and are easy enough on the hands, but more than once we found ourselves resting our digits on the M750's keys and activating them by accident; that super-shallow 2mm actuation depth, coupled with a not quite strong enough spring, makes the QX2 switches unsuitable for the more heavy-fingered among us. Plus, if you're not entirely deft, the light touch could lead to an increase in inadvertent typing errors. We do try to avoid the clichéd "personal preference" argument in reviews, but this foible of what are otherwise exemplary switches is something to be aware of.

We can't argue that SteelSeries has gotten everything else right, either. The Apex M750 lacks a few of those luxury options that would really make it a top-line driver. There's no braided or detachable cable, for instance, and we don't have supreme confidence in the long-term integrity of the one that's included. There's no USB or media pass-through, either. And the height adjustment just consists of an alternate pair of rubber feet, included in the box—sure, this grips the desk and doesn't let go, but swapping feet is a tricky solution to a problem that was adequately solved 30 years ago by clip-out legs. However, for all the M750's little issues, SteelSeries has done the big things just right, and satisfied all our senses. **–ALEX COX**

VERDICT 9

SteelSeries Apex M750

⊞ **TYPING BLISS** Great key feel and sound; super-impressive lighting; solid construction.

⊟ **TYPING MISS** Questionable cable; awkward rubber feet.

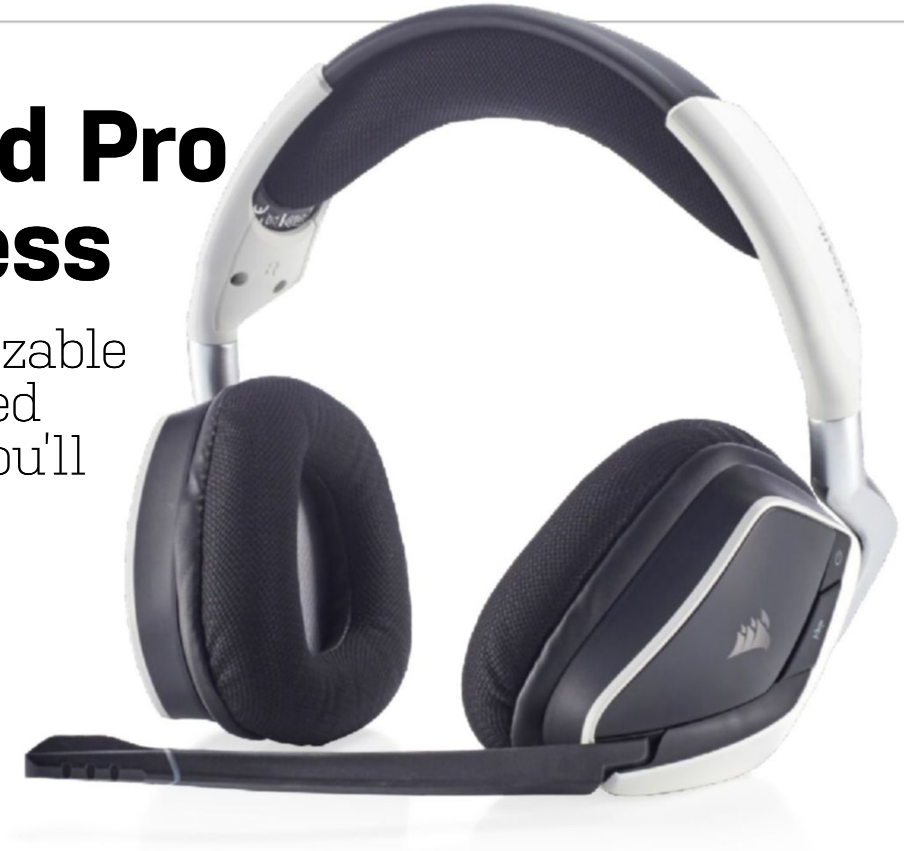
$140, http://steelseries.com

SPECIFICATIONS

Switch Type	SteelSeries QX2
Form Factor	Full size
Media Keys	F-key shortcuts
Macro Keys	Software customizable
LEDs	RGB
N-Key Rollover	104-key (all)
Pass-Through	None
Dimensions	17.9 x 6.0 x 1.8 inches
Warranty	Two years

Corsair Void Pro RGB Wireless

Millions of customizable colors, but it's the red battery indicator you'll see most often



THERE'S A RENEWED push toward wireless from peripheral manufacturers lately, evidenced by SteelSeries's great Arctis range, and more pertinently by Corsair's cable-free Void Pro RGB Wireless. As consumers are responding to the word with fewer negative preconceptions, there's a gap in the market to be occupied by the headset that gets it all right, at the most inviting price. But let's be direct: That headset isn't the Void Pro RGB Wireless.

That's not to say it's an outright bad product. There's plenty to like, much of it what we liked about the last round of Void headsets: decent, affordable sound, driven by 50mm drivers that don't distort at higher volumes, sensible controls, and a comfortable, adjustable fit. Notable upgrades in this new model of Void are an improved microphone and memory foam pads. Starting with the mic, it sounds about the same as it does in the old model to our ears: a bit quieter than most and lacking low-end, but featuring strong and precise noise-canceling, which can kill the sound of mechanical keys tap-tapping away without clipping your voice.

Instead, the improvements lie in the mic arm. It's a more flexible rubberized design this time, which can be positioned to fit, and there's a mute switch built in, so that pushing the mic into the upward position mutes it. We like the red light on the mic, which indicates it's muted, too, though we're not sure why there's also a separate mic mute button on the left earcup. It made sense to put it there in the old model, but now with the hinge mute and a power button positioned precariously above the old mute button, it seems unnecessary. The memory foam pads are an unreserved improvement, though. Although neither this nor the previous Void feel luxurious in their construction materials, this softer padding around the earcups and under the headband goes some way to addressing that. It certainly helps in lengthy wear sessions, although lasting comfort has long been a virtue of this series.

LIGHT SENSITIVE

Back to the wireless, though. We'd heard reports that running the RGB lights severely impacted the 12-hour battery life Corsair states in its specs, and found that, sure enough, we got under five hours of life when running a lighting pattern through them (customizable via the CUE software). Turning lighting off completely actually extended the battery life marginally over 12 hours, so it's clear lighting is a huge drain on battery life. More annoying still, the headset doesn't turn itself off after you shut your PC down, so it's very likely you'll return in the morning to some dead cans.

Putting those bizarre issues behind us, it has plenty else to offer. If you're a virtual surround hater, these cans won't convert you, but for everyone else, the laudable Dolby Headphone 7.1 digital surround is well implemented. We still prefer to run them in stereo, though, for the improved precision to the mids and low-end frequencies, and that's easily achieved by hitting a single button in CUE. As with all other headsets in Corsair's fleet, there's a range of EQ presets to cycle through in there, and although we're stick-in-the-muds who always favor a flat response, it's nice to have the option. The wireless range extended across our entire apartment, including through walls, so there are no problems there. It's worth knowing that the supplied charge cable is just that, though—you always need the USB wireless receiver to use these cans. Moreover, mobile device cables such as those offered by SteelSeries's Arctis models are absent here, and we feel that lack keenly.

Totting up all the pros and cons, it's another competent offering from Corsair, but it doesn't really deliver on its central idea: wireless RGB sound. If you don't care about lights, opt for an Arctis. If you do, choose a wired headset. **–PHIL IWANIUK**

VERDICT 7

Corsair Void Pro RGB Wireless

⊞ **GO PRO** Improved microphone; comfier feel.

⊟ **NULL AND VOID** Lighting kills battery; sound isn't standout.

$100, www.corsair.com

SPECIFICATIONS

Driver Type	50mm
Impedance	2,200 ohms
Frequency Response	20Hz–20KHz
Microphone Type	Unidirectional noise-canceling
Connectivity	USB (wireless receiver)
Range	40 feet
Battery Life	12 hours
Weight	13.8oz

Fractal Design Meshify C

Excellent budget offering with not-so-tiny tempered glass

THE CASE has the simplest job of all PC hardware: house all the other components, and look good while doing it. Granted, keeping everything cool, quiet, and dust-free is important, too, but compared to the bazillion floating-point calculations your graphics card has to do, it's an easy life. Yet picking a model that checks all these boxes is never as easy as you'd first imagine. We're often channeled into distinct routes by manufacturers: quiet cases or cases with great cooling options. Budget cases or cases that don't tear your hands to ribbons when you try to build in them.

Fractal's Meshify C forces no such compromise on you in exchange for its $90. As the name suggests, the all-mesh front panel sets the case up for a clear airflow, and despite its budget pricing, the tempered glass side panel offers a high-quality aesthetic. Inside, a PSU shroud and excellent cable management options double down on those existing visual and airflow strengths, along with nice touches such as a bracket behind the motherboard where up to three SSDs can be mounted. These can also be removed during a build to allow easy access to the motherboard's rear when fitting a CPU cooler, which is a real blessing, because fitting coolers is often the most arduous part of a build. We've got the scars to prove it.

The enclosure at the Meshify's base also houses storage bays, and although it's always preferable to use a modular PSU in this type of setup, in order to make life easier when it comes to cable management (not to mention getting the rear panel back on the thing), we were able to fit a non-modular PSU, with ample room to store the unused cables between the unit itself and the storage bays. The internal panel on to which the motherboard is fitted also features three handy cutaways at the base, just above the PSU shroud, through which connections at the bottom of the motherboard, such as HD audio and USB headers, can be kept neat and tidy, too. To finish it all off, the side cutaways are fitted with rubber grommets and are slightly angled, which enabled us to make those connections to the GPU that bit more easily.

Despite housing ATX, mATX, and ITX systems, this case runs shorter along its length than most mid-tower models. We like the visual effect of that, and the space-saving, but it does mean that three-fan graphics cards are a really tight fit. Fractal's spec sheet states 12.4 inches of clearance for GPUs and, true enough, we could install our 12-inch Radeon HD 6990, but it was a cigarette paper's width away from the supplied Dynamix X2 GP-12 120mm front fan. There's always the option of removing that fan, but it's something to be aware of if you're packing an oversized chunk of PCB on graphics duty. Options for fitting more than the two supplied 120mm fans or swapping them out for radiators are good—there are seven fan mounts throughout the case, and room for radiators at the front and top, with dust filters placed here and below the PSU. Bonus points are awarded for a front removal mechanism for the bottom filter—no need to move the whole machine to access it.

We're left with very little to grumble about. The only obvious concessions to its sub-$100 pricing come in the top panel magnetic dust filter, which isn't very closely fitted to its inlay and looks noticeably cheaper than the rest of the case, and a flimsy front panel, which has a bit too much give to instil any confidence. That's literally it: two tiny grumbles about an otherwise exemplary case with features you'd expect from a much pricier model. Meshify, it was a pleasure to build in you. –PHIL IWANIUK

VERDICT
9
KICK ASS

Fractal Design Meshify C

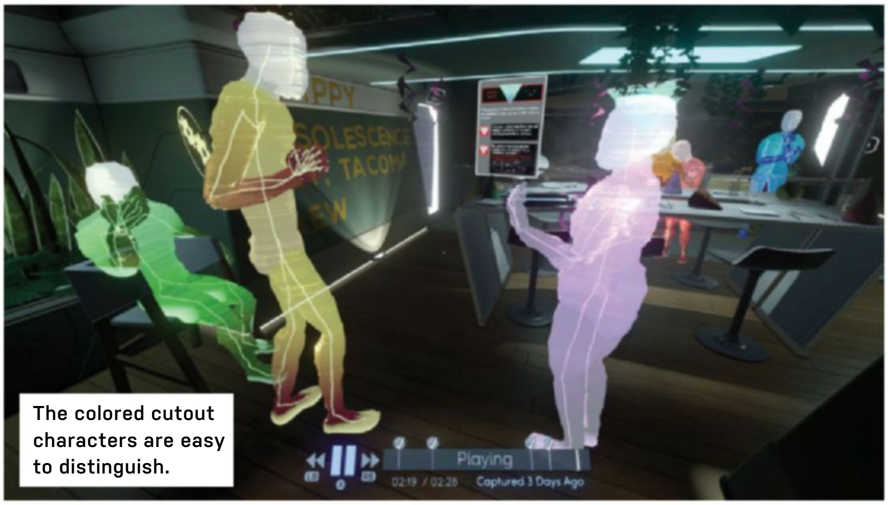
➕ **FRAC YEAH** Great airflow; easy cable management; classy window.

➖ **HOT MESH** Flimsy in places.

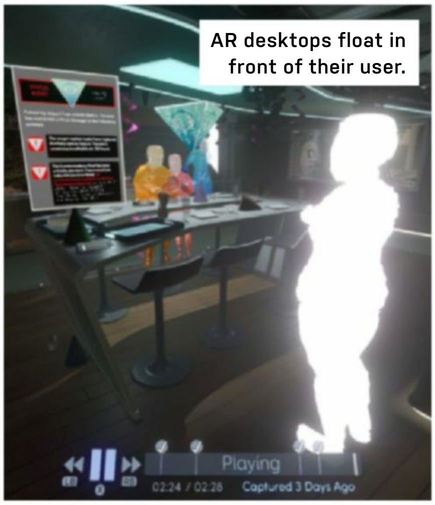
$90, www.fractal-design.com

SPECIFICATIONS

Form Factor	Mid-tower
Motherboard Support	ATX, mATX, ITX
Available Colors	Black
Window	Yes
3.5-Inch Support	2
2.5-Inch Support	3
Radiator Support	Up to 360mm (front), 240mm (top), 120mm (rear)
Fan Support	Up to 7x 120mm; or 4x 140 mm, 2x 120 mm
Dimensions	16.1 x 8.5 x 17.8 inches
Graphics Card Clearance	12.4 inches
CPU Tower Clearance	6.8 inches
Weight	17.4lb



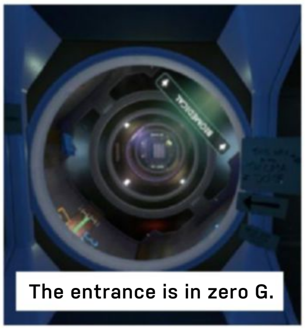
The colored cutout characters are easy to distinguish.



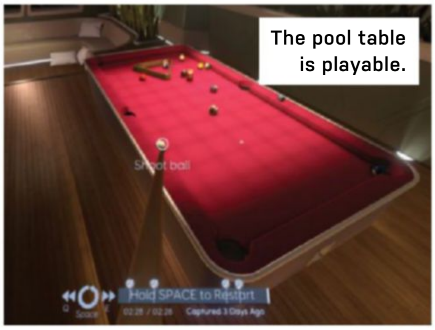
AR desktops float in front of their user.

AR Crew Record Data... Recovered!

This AI-organized party looks no fun.



The entrance is in zero G.



The pool table is playable.

Tacoma

Space makes people chatty, and you're here to watch

WE'RE BACK IN THE VOID after last month's *Lone Echo*, but things are very different aboard abandoned space station Tacoma.

There's no VR for one thing, centrifugal force mostly preventing the free-floating that made the Kronos II so exciting. You do have AR, however—the station's systems interface with your suit or implants to display a floating display in front of you.

Tacoma is a space station but needn't be. You could be exploring anywhere, and Fullbright has previous in this area, having produced 2013's *Gone Home*. It's not the larger environment that matters, but the detail. The contents of lockers are what you've come to see, not the austere beauty of nebulae and planetary rings.

There's a plot of sorts. You've come to download the station's computer core, and that means placing a magic box on various conduits and waiting until the completion percentage inches its way painfully up. You need something to do while waiting—you could just stand there, but with 0.1 percent completion every 10 seconds or so, it's not recommended. So you go off and explore.

That's where the AR comes into its own. Recordings of the station's erstwhile crew are recoverable from the environments, and while you watch these, you'll find fragments of their own AR systems can be viewed. From this you build up a picture of not just what happened to the astronauts—a tale of corporate scheming and AI gone wrong—but also the lives, hopes, fears, and dreams of the crew members themselves.

This is where the game becomes most affecting. The crew are fully drawn, a diverse bunch sympathetically treated, packed with human flaws, needing instructions on how to have a good time, and stuck in space with little to do but think about their loved ones and failures. Gently, you tease out their stories, and that of the entire human race since 2017 along with them. And as you slowly—not that slowly, it's a quick game to finish—assemble the jigsaw of events and thoughts, something emerges from the conjunction of environmental design and conversational vignettes that makes the world feel complete.

It's perhaps not the most interactive game, as you mainly stand and watch, affecting events with pause and rewind buttons that don't actually change the events themselves but rather your perception of them. Just about anything can be picked up and examined, and you'll watch every recording several times, following each participant as their audio cuts out when they leave a room. In a concession to playability, discovering emails and voice messages in AR makes the device you've attached to the wall tick toward completion faster.

Exploration games—walking simulators by another name—might not be to everyone's taste, and the somewhat primitive graphical style will do less to draw in players than the low system requirements and bargain price. But this voyeurism game shouldn't be overlooked, as it does more to advance the cause of great writing and emotional characterization in games than a thousand ravening warriors ever could. **–IAN EVENDEN**

VERDICT

8

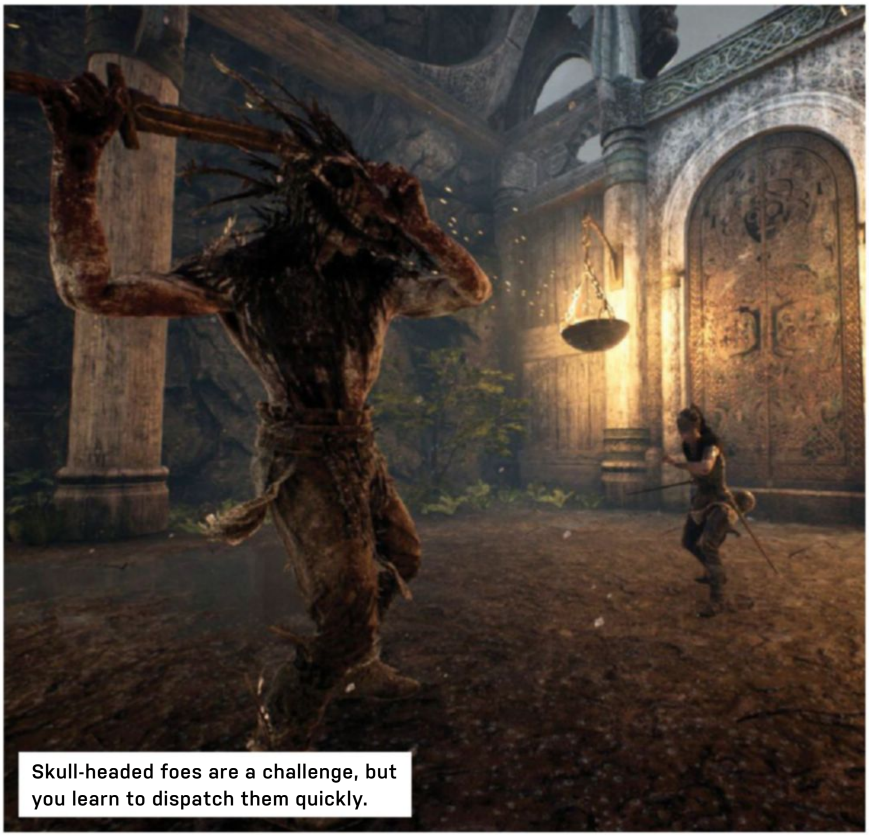
Tacoma

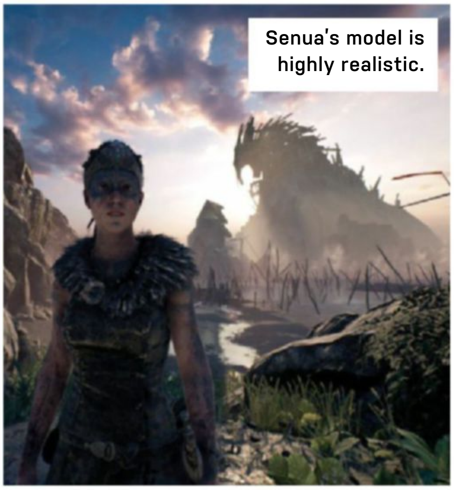
+ SPACE ODYSSEY Well-drawn characters, feels complete.

– BLACK HOLE Short, crude-looking, slow.

RECOMMENDED SPECS 2.9GHz Intel i7 or equivalent, 8GB, GPU with 2GB of VRAM.

$20, www.tacoma.game, ESRB: Teen


Skull-headed foes are a challenge, but you learn to dispatch them quickly.


Senua's model is highly realistic.

The lighting is extremely pretty at times.

Hellblade: Senua's Sacrifice

A Pict who paints a thousand words

A LONE WARRIOR MAKING a redemptive journey into a terrifying place is something we've all seen before. Add mythology, haunting structures, some really dark bits, basic shape-matching puzzles, and creepy-looking guys who want to kill you, and the fantasy hack 'n' slash game is complete. How do you make it fresh again?

Ninja Theory, developer of PlayStation's *Heavenly Sword* and multiplatform *DmC,* thinks it can do it with characterization. Senua is a Scottish tribeswoman who has seen her home overrun and lover killed by Scandinavian invaders. So, she carries his severed head into the Norse hell to avenge him. On its own, that would be easy to mock, but Ninja Theory has found a way to scatter uniqueness throughout the game: making Senua mentally ill.

She hears voices and has hallucinations. You can never be sure whether what you're seeing is really real, or if it's only real to Senua. Maybe she spends the whole game locked in a hut, her adventure playing out only in her mind, or maybe she really does it. Maybe those are the invaders she's slaying, not skull-headed demons. The developers worked with neuroscientists and other experts to get the tone right, hoping to stave off the backlash a thoughtless treatment of the subject would bring. Senua's blue painted face and matted hair may mark her out among videogame heroines, and Melina Juergens's mo-cap performance is spot-on, but it's her voices you'll remember long after the game is completed.

The Unreal 4-powered environments, heavy on effects, often take a trip to the brown world, all mud and dark caves, but the sound design is remarkable. It tells you up-front that it's best played with positional headphones, and whacking on a pair surrounds you with the voices of Senua's mind, cajoling and questioning you, warning you, sowing doubt. It's one of the greatest uses of voice acting and 3D audio we've come across, and spinning on the spot in an early enemy-free section is an excuse just to drink it all in. Played with speakers, even surround sound, just isn't such an intense experience, with stereo being particularly weak, thanks to a headset's ability to drown out ambient noise.

With no HUD, and subtitles off by default, it would be easy to describe it as "cinematic." But almost no one would make a film like this; it's too harsh, too contrasting, and exactly the sort of thing games do well.

Combat is informed by its creators' work on *DmC,* becoming a fluid dance of rolls, blocks, and strikes. That the game doesn't think to tell you any of this is annoying—an early battle you're not meant to win gives you just enough insight to know how to fight, even if the camera decided to tuck itself away behind a tree the first time we played it. Difficulty is adaptive, but if you're struggling, and worried about the game's threats to delete your save, it's worth setting it in easy mode and persevering, because *Hellblade* has sights to show you, and they're not all hellish. **–IAN EVENDEN**

VERDICT 8 **Hellblade: Senua's Sacrifice**

+ STRIKING Looks OK; sounds amazing; lots to reveal.

− VIKING Puzzle sections under-developed; lack of combat instructions.

RECOMMENDED SPECS Intel i5 3570K or AMD FX-8350; 8GB RAM; GTX 770 with 2GB VRAM or Radeon R9 280X 3GB.

$30, www.hellblade.com, ESRB: M

LAB NOTES

ALAN DEXTER, EXECUTIVE EDITOR

Intel's Perplexing Next Generation

Forget all you know about its lineup

intel
CORE i7
8th Gen

What's the difference between a Core i7 and i5? Careful, it's a trick question.

INTEL'S EIGHTH-GENERATION CPUs are almost upon us, and they're already looking intriguing, if only for the fact that we'll see three technologies under that banner: a Kaby Lake refresh (14nm+), Coffee Lake (14nm++), and Cannonlake (10nm). It's the laptop chips that we'll see first, though, and I'm more stoked about these than the desktop counterparts, if only for personal reasons—I'm in the market for a new laptop.

With Ryzen kicking things up elsewhere, laptops feel like Intel's last bastion of dominance. Its tech has focused on laptop-loving efficiency for years, and AMD has always struggled to get chips into portable systems. Intel has come out swinging with its eighth-gen chips, though, squeezing an extra pair of cores into its mobile offerings.

If you're familiar with Intel's desktop lines, you'll know that traditionally the difference between a Core i7 and a Core i5 is that the latter doesn't support HyperThreading. But with its eighth-gen chips, that isn't the case. Four 14nm chips have been announced so far: Core i7-8550U, i7-8650U, i5-8350U, and i5-8250U, and the weird thing is that they all have four cores and are capable of handling eight threads at once. The difference? Cache. Both Core i7 chips have access to 8MB of SmartCache, while the lowly Core i5s only lay claim to 6MB. A difference, but not quite in the same league as the outgoing lack of HyperThreading, or the fact that the equivalent chips from the previous generation had half the number of cores.

These chips are ultra low-power models designed for ultrabooks, two-in-ones, and all-in-ones, with a TDP of just 15W, but they do indicate that Intel isn't taking anything for granted anymore, even if it does mean messing with our understanding of what separates a Core i7 from an i5. It looks like I couldn't have picked a better time to upgrade my old laptop, it's just a case of seeing what the system builders do with these chips now.

JARRED WALTON

Senior Editor

Apple has just launched its latest iPhones, the 8, 8 Plus, and the new super-sized iPhone X (pronounced "ten," which makes me wonder what Apple is going to do after the inevitable iPhone 9). The X is almost entirely screen on the front, with a notch out of the top for the camera. The A11 processor nestled inside could probably even give an old Core 2 Duo a run for its money, but the iPhone X starts at a staggering $999, which is insane even by Apple standards. You can build a complete gaming desktop for less than that, and it will still be running absolutely fine in five years. I think the new live emojis basically sum things up, which are a step down even from the abysmal *Emoji Movie.*

BO MOORE

Technology Editor

Based upon my shellacking of the Predator 21 X's 1080p screen in my review (pg. 82), you might think I'm a high-resolution purist, only willing to feast my eyes upon panels of a certain pixel density. Quite the opposite, in fact! 1080p is actually my resolution of choice, giving me access to higher refresh rates at a reasonable price point. 4K is chained to 60Hz until the next generation of high-end gaming panels arrives early next year, and while 1440p has a plethora of high-speed options, they aren't cheap. With 1080p, I can easily hit top-end frame rates and eliminate screen tearing with not-absurd hardware—and when I'm spinning my crosshairs around to track that ulting Genji, I call that a win.

Editors' Picks:
Digital Discoveries

Tuan Nguyen, editor-in-chief, and Zak Storey, reviews editor, reveal their latest tech loves

DELL S718QL 4K LASER PROJECTOR

I'm a fan of projectors. There's nothing like having a massive image on your wall to gawk at while relishing in the fact that no "monitor" can come close to a projected image. Right now, I use two 32-inch 4K displays, but Dell's new S718QL is in a league of its own.

The S718QL is no ordinary projector. First, it supports 4K, which is a requirement for me now. I can't go back to 1080p. Second, it's got lasers! There's no DLP. There's no LED. There's no hot bulb to burn out. The laser diodes in the S718QL last many times longer, and illuminate much better, with unmatched contrast. But the unique thing about the S718QL is its short-throw design. What's that?

Usually, projectors have a minimum distance that they need to be away from a screen or wall to produce a decent image. If you want, say, a 100-inch image, you have to place a typical projector across the room, several feet away. Not so with the S718QL. Dell's short-throw laser design enables the projector to produce a sharp and crisp 100-inch image while sitting just a foot away from the wall. That means projector positioning is flexible and image contrast is even better. This is my ultimate "display."

$5,000, www.dell.com

HELLBLADE: SENUA'S SACRIFICE

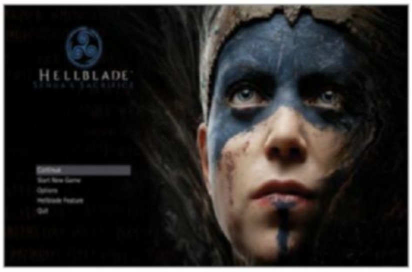
Mixing Norse and Pictish mythology, *Hellblade: Senua's Sacrifice* (see pg. 91) follows a young Pict warrior from the Orkney islands as she pursues the Viking raider party that slaughtered her village and decapitated her lover, into the depths of Viking Hell.

Except she's not entirely there. Senua suffers from an aggressive form of psychosis, that causes hallucinations, visions, and voices. The way the devs have handled it is incredible. Speaking to people who have suffered from psychosis in real life, and working with a variety of doctors and psychologists, Ninja Theory has very graciously tackled an issue not often seen in the gaming industry.

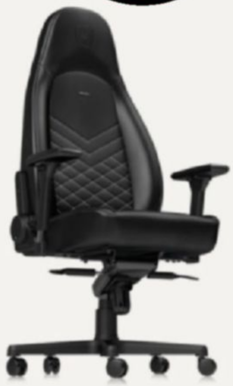
The game is exceptionally cinematic, with barely any user interface whatsoever. But it's the technology that really draws your breath away. Whether it's the binaural 3D audio voices whispering in your ear, or the graphical hallucinations and fading superimposed live acting on top of in-engine game cinematics, no two moments or two environments feel the same.

If you've ever battled the big black demon, you'll find it an unnerving experience that's all too relatable.

$30, www.hellblade.com



GEEK TESTED & APPROVED



Noblechairs ICON Gaming Chair

IT TOOK ME A LONG time to get my head around "gaming chairs"—those bucket seat designs that fool nobody. Seriously, there are no Gs in gaming. And if there are, you're doing it wrong. Problem is, if you're looking for a premium office chair, you're penned into one style of stool. As much as you hate them, gaming chairs are competing against one another in a far more aggressive market than standard furniture companies. Which means better designs, better prices, and greater improvements.

My gripe is that ridiculous bucket style. I don't need that—I want a chair that looks like an office chair, not some plumped-up, go-faster bucket that would look more at home in a stock car than next to my glamorous setup.

So when Noblechairs announced its latest range of ICON gaming chairs, it was a no-brainer. Having used the bucket variant at work, I trotted the black/platinum one home, placed my posterior on it, and realized how much better it was. Consisting of a faux leather finish, hard padded armrests, memory foam, a variety of adjustments, tilts, and rockers, it's a joy to sit in.

I have two setups for it: a relaxed style, where I can prop my feet up on my desk, and a serious "I care about my posture" style, with a higher angled backrest. It's a fair price if you've got the dollar, and its comfort, ease of construction, and luscious style makes it stand out from the rest of the gaming chair market. **–ZS**

$370, www.noblechairs.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Advanced Networking
> Windows Wisdom
> Problem Pins

Networking Perfection

I've never written in before, but the July issue's "Set Up the Perfect Network," by Nick Peers, made me scratch my head and think, "Is this really Maximum?"

Don't get me wrong—he did a great job. His information is correct for small home networks, if you happen to have just a cable modem for your WAN, a wired desktop, a network attached printer, a laptop, and not much else on your network. If that's the case, one of the good quality Port Address Translation (PAT) type devices mentioned in the article is a great choice.

Unfortunately, something like that would never cut it in my home network and many others I have come across as we move further into a more connected household (connected refrigerator, stove, and so on).

Please see the photo of the small rack/case that houses the equipment (above-right). Side note: Notice the Apple II theme. I happen to collect Apple II machines, so we wanted to give the network cabinet a theme for fun. It's painted Platinum like the later Apple IIe Platinum Computers, and the patch cables, along with the Keystones, are done in the Apple Color Pattern. It even has an authentic color Apple window decal.

It would be great to do a follow-up article, as I am sure I'm not the only reader for whom four LAN ports are not going to handle their home network. I chose Ubiquiti for my equipment, but Netgear and Linksys/Cisco both make some great and affordable SOHO/non-enterprise level gear that is well suited for a medium to large home install. **–Copper**

The Apple II theme isn't accidental.

EXECUTIVE EDITOR, ALAN DEXTER RESPONDS: You're right, the original article was indeed just to show what you can do with a smaller network, with the idea that you can expand on it for larger networks. It's amazing how many devices we have connected these days, especially when it comes to tablets, phones, and everything else that we routinely connect up wirelessly. A more advanced feature is already lined up.

Pro Thinking

I will keep this real simple: Why would you NOT use Windows 10 Pro in an $18,000-plus 2017 Dream Machine that is supposed to really push the limits of all you can do? I use Win 10 Pro on my $3,000-plus dream machine. **–Jay Martinson**

EXECUTIVE EDITOR, ALAN DEXTER RESPONDS: We may exhibit a hang-the-cost attitude when it comes to hardware, but we're still driven by performance, and that extends to the OS. The truth is, there's nothing in the Pro version of Windows 10 that brings a performance boost to our Dream Machine. Sure, you may want things such as BitLocker, Domain Network support, Remote Desktop, Hyper-V, and so on, but none of these will make a difference to the underlying speed. The only feature of any interest is the amount of RAM supported: Windows Home supports up to 128GB, while Windows 10 Pro can take you to 2TB. Not an issue for this year's machine, but it may be in the future.

Custom Loader

I've been trying to install the Grub Customizer as described on page 53 of the June 2017 issue. I've entered all the steps, but when I do the last step—`sudo apt-get install grub-customizer`—I get an error: "This PPA does not support xenial."

What do I need to do? I'm running Mint 18.2 Cinnamon edition. **–Kerry Gifford**

↘ submit your questions to: comments@maximumpc.com

EXECUTIVE EDITOR, ALAN DEXTER RESPONDS: You'll quickly find yourself disappearing down the rabbit hole trying to track down why this is happening, but it generally comes down to the fact that the Grub Customizer isn't in the default repositories. The app is maintained by Daniel Richter, and the commands in the feature show you how to add the repository so that you can install it.

It looks like something's going awry at the install stage though—Xenial is the codename for Ubuntu 16.04, which forms the basis of your Mint 18.2 install. You usually see a "This PPA does not support xenial" error when the application is out of date, but Grub Customizer has been updated recently, so we suggest retrying (we don't have a problem with the app here—we've just double-checked). You may also get this message if it's already installed—so that's worth checking as well. The only other thing we can think of is that you're skipping the `apt-get update` after adding the repository, which will cause it to fail, so make sure you do so. Failing that, you can achieve pretty much everything you can do with Grub Customizer manually, although as this affects how your machine boots, you need to get a really good grasp of how it works first.

Incompatible Pins

Based on the article by Alan Dexter in the August 2017 issue of *Maximum PC*, I have a question: Where exactly is one supposed to connect the case fan of the Phanteks Enthoo Evolve ITX on the Asus ROG Strix B250I gaming motherboard? I can only see two places from the motherboard manual to connect fans, and both have four pins. The female connector for the fan has three openings. Am I missing something? This is my first attempt at a build, and I am hung up here. **–Don Thomas**

[READER SPOTLIGHT]

DREAM BUILD

I wanted to share a few pictures of my gaming PC build. I saw a post on your Facebook page about your Dream Machine, and wanted to send a few pics of my own build. I use a wheelchair to get around, but it didn't stop me from building my own PC! Thanks for all the amazing magazines, and I can't wait to see the latest issue!

–Austin Davert

EXECUTIVE EDITOR, ALAN DEXTER RESPONDS: You're not missing anything, just a slight oversight on our part. The four pins on the motherboard support PWM fans, while the three-pin versions are DC. You can slide that three-pin female connector on top of the four-pin male header (and connect a four-pin fan to a three-pin connector as well). We do it so often, we didn't even think to comment on it. It'll only fit one way round, so don't worry about getting it wrong.

Smaller is Better

The "Mini-ITX vs. ATX" article in the Sep 2017 issue doesn't say anything that most wouldn't already know. It doesn't go into how cool Mini-ITX motherboards are. When the third-gen Core i5 came out, I built my first Mini-ITX system—a gaming rig that I could take to LAN parties. I used a BitFenix Prodigy case. The case has room for the Asus R9-390 video card. The motherboard I wanted to try was the Asus Z170I Pro Gaming. I found out I could put a Core i7-7700k in my system with a BIOS update. I also added a Corsair H100i. I set the video card to run my three 24-inch Asus monitors, so I could play *CS:GO* over three screens. The mobo had EZ overclocking options, so I got the CPU up to about 5GHz. I have one SSD for Windows, and one 4TB for games and storage. The Mini-ITX board can have up to 32GB of RAM, which I put in. For music, I have a USB DAC/amp and a high-end USB mic. I agree at the end of the article that Mini-ITX motherboards work as hard as ATX boards. For the size of what I built, it does so much, and is easy to take to LAN parties. Everyone should take a look at Mini-ITX. **–Chris Yusko**

EXECUTIVE EDITOR, ALAN DEXTER RESPONDS: Part of the point of the article was to highlight the fact that smaller form factors won't hold you back. While you may have fallen in love with the convenience and versatility of these tiny machines, there are plenty of readers who are unaware of their charms. Maybe your letter will convince a few over to your way of thinking.

Processor Elimination

Just getting around to the Ryzen 5 1500X CPU review in your July issue. It looks solid, but is the R5 line more about price at four-core processing? AMD's eight-core line was already priced competitively, so I was curious about the move to four-core—it does box Intel into "innovate or keep pushing cores." I'm weighing my options, and Intel's Kaby Lake is out as I don't like the name (sad but true, and a few other choice reasons). Skylake-X is impressive, but too expensive. R7 1800X has my eye at the moment, just waiting for the last roll-outs this fall. I think you've answered this before—maybe I just need to hear the answer again. With a $500 CPU budget, should I buy now, or wait for the year-end review? **–Ryan Anthony**

EXECUTIVE EDITOR, ALAN DEXTER RESPONDS: The Ryzen CPU lineup is complete (though we expect to see APUs before the year's out), and we've given our opinion on pretty much every chip: They're all good, but there are some standout offerings. The Ryzen 7 1800X has the raw power, while the Ryzen 7 1700 can hit the same performance at a cheaper price point (but you need to overclock it to get the most from it). The Ryzen 5 1600X is the best overall value proposition, if you don't need all eight cores, while Threadripper demolishes the high end. We are about to get a new generation of Intel chips, which could mix things up, though I doubt we'll see any significant price drops, so we recommend pulling the trigger on the Ryzen 7 1800X, and enjoying your new build.

Future

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THE BUILDS

BUDGET

INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Evolv ITX	$65
PSU	EVGA 450B Bronze	$45
Mobo	MSI B250I PRO Mini ITX	$80
CPU	Intel Pentium G4600	$87
GPU	EVGA GeForce GTX 1050 Ti SC Gaming 4GB	$150
RAM	8GB (2x 4GB) Patriot Viper Elite DDR4 2400	$69
SSD	Plextor PX-128S3C 128GB **NEW**	$56
HDD	1TB WD Blue 7,200rpm	$50
OS	Ubuntu Desktop Linux 16.04 LTS 64-bit	$16

Approximate Price: $618

WE'RE ALL ABOUT SAVING CASH when it comes to our budget build, so we were eyeing up the windowless version of the Enthoo Evolv ITX case, when we noticed that the one we had from last month had dropped $5. We saw a $10 saving on our motherboard of choice as well, which we're never going to turn down. On top of that, we've seen the pricing on graphics cards begin to calm down, which meant we could snap up a Gigabyte GeForce GTX 1050 Ti for a slightly more reasonable $150—another $10 saving over last month's card. The card comes with *Rocket League*, too, which is a great little game. RAM was $1 more expensive for the same memory as last month, which could be a sign that RAM price rises are coming to an end. That's probably just hopeful thinking, though. We did see a price hike on our default SSD as well, so have switched to a Plextor drive to help bring the overall cost of this machine to $28 less than last month.

MID-RANGE

INGREDIENTS

PART		PRICE
Case	NZXT S340 Elite	$95
PSU	EVGA SuperNOVA 550 G2	$90
Mobo	MSI X370 SLI PLUS	$140
CPU	AMD Ryzen 5 1600 **NEW**	$215
Cooler	Corsair H100i v2 + bracket	$115
GPU	Zotac GeForce GTX 1070 Mini 8GB	$415
RAM	16GB (2x 8GB) G.Skill TridentZ DDR4 3200	$139
SSD	256GB Samsung PM961 M.2 PCIe NVMe	$119
HDD	Western Digital Blue Series 1TB 7,200rpm	$50
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $1,478

THERE ARE PLENTY OF OPTIONS when it comes to which Ryzen processor to drop into your X370 motherboard, ranging from just $105 for the Ryzen 3 1200 up to $450 for the Ryzen 7 1800X. For a while now, we've been recommending the Ryzen 5 1400, just to try to hit a reasonable price point, but the world of cryptocurrency has undermined this anyway, so this month we've decided to go with the chip we've wanted in our mid-range machine since day one, and that's the six-core Ryzen 5 1600. It's a little pricier than the previous Ryzen 5 1400, but you do get 50 percent more cores for the extra $50 outlay. The good news is that we saw a significant price drop on the GTX 1070 Mini—$35, to be exact—and when combined with a $10 saving on the SSD and another $5 reduction on the case, overall we're looking at the same total price as last month, yet we've come away with a six-core machine instead of a quad-core PC.

TURBO

THERE ISN'T A LOT OF GOOD NEWS when it comes to the pricing of our turbo build this month. Memory is the big culprit once again, with the G.Skill TridentZ kit we've previously used seeing a $40 price increase over last month. This is enough to make us look for an alternative, but it actually turns out that even at its elevated cost, it's still the cheapest 32GB option out there. Ouch!

We saw a $10 increase on the power supply, too, which isn't something that happens often. Even so, we're happy to keep with the Corsair RM750X, because it has served us well. There was a $2 increase on our SSD of choice, although it'll take a lot more than a couple of bucks to turn us away from the stunning 960 Pro. At least until its replacement lands.

Unfortunately, the graphics card we recommended for last month's turbo build, the Gigabyte GeForce GTX 1080 Ti Gaming OC Black, was out of stock, and had seen a $40 price hike in the meantime, too. We're loathe to drop the 1080 Ti from our high-end build, simply because the performance is so incredible, so instead of keeping one hand on our wallets and dropping down to the non-Ti version of the card, we've instead invested in the EVGA GeForce GTX 1080 Ti SC Black Edition. This twin-fan card has a base clock of 1,556MHz and a boost of 1,670MHz, which is significantly more than the stock frequencies of 1,480MHz and 1,582MHz respectively. So, while there isn't a lot of good news here, ultimately this is a slightly more powerful gaming rig than last month's build.

For more of our component recommendations,
visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART		PRICE
Case	Phanteks Eclipse P400S Tempered Glass Silent Edition	$90
PSU	Corsair RM750X Modular Gold	$120
Mobo	Asus Prime X399-A	$350
CPU	AMD Ryzen Threadripper 1920X	$800
Cooler	NZXT Kraken X62 280mm AIO	$160
GPU	EVGA GeForce GTX 1080 Ti SC Black **NEW**	$750
RAM	32GB (4x 8GB) G.Skill TridentZ DDR4 3200	$290
SSD	512GB Samsung 960 Pro M.2 NVMe	$300
HDD	4TB WD Black 7,200rpm	$186
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $3,146

UPGRADE OF THE MONTH

AMD RYZEN 5 1600

Now that we have the full Ryzen family to pick from, we're beginning to find ourselves drawn to specific chips at certain price points. As we've shown in this month's mid-range build, this six-core chip has a lot to recommend it—with plenty of multithreading oomph and a max turbo of 3.6GHz to help get the job done where straight line frequency matters. The pricing is good, and the Wraith Spire cooler puts in a good turn keeping the chip chilled if you don't have the funds for an all-in-one cooler. A great mainstream chip.

$215, www.amd.com

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D. New Alienware Advanced Gaming Mouse - AW558.
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F. New Alienware 34 Curved Monitor - AW3418DW.
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H. New Alienware Elite Gaming Mouse - AW958.
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